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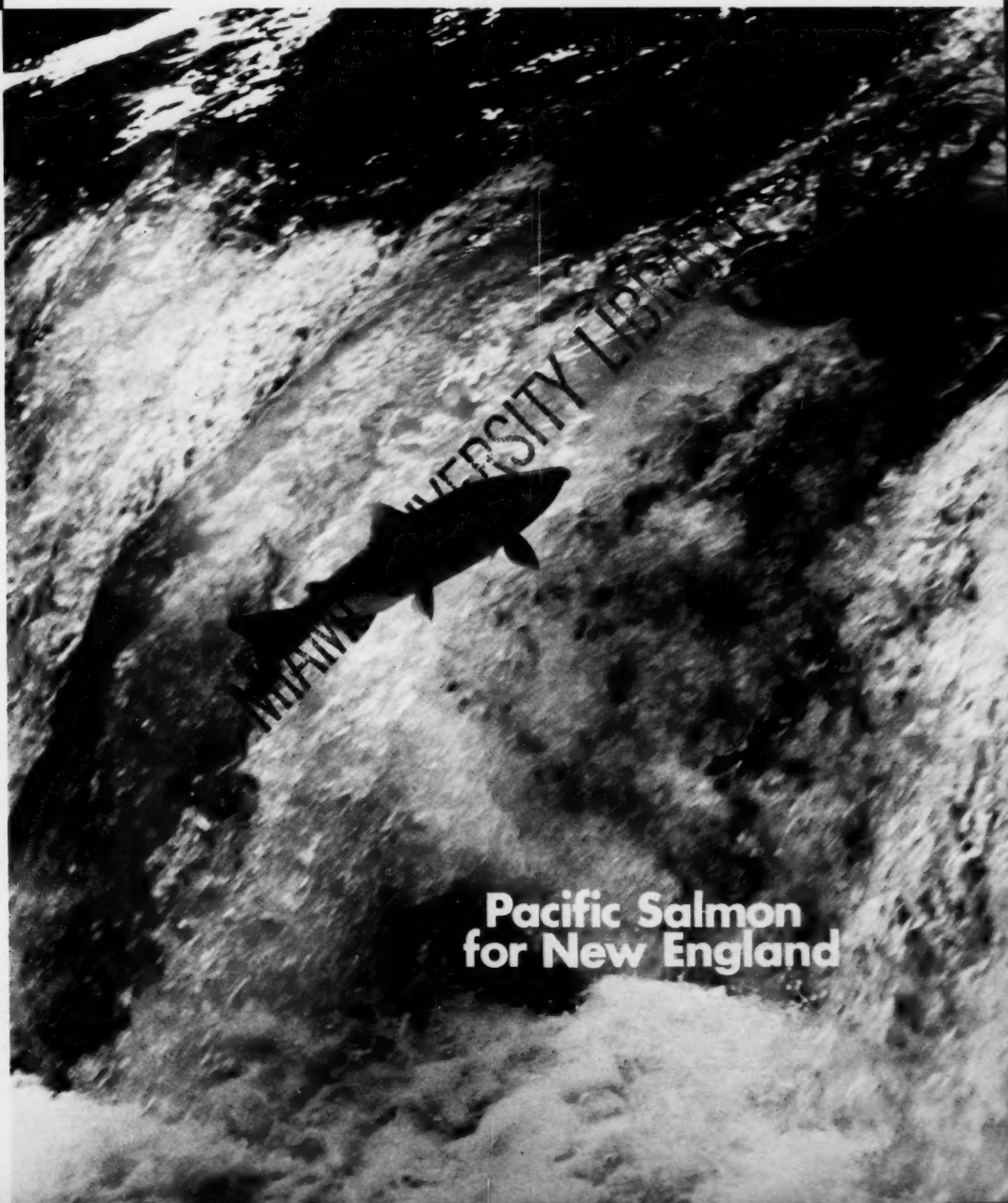


# Marine Fisheries

## REVIEW

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service

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**Pacific Salmon  
for New England**

October 1973  
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# Marine Fisheries Review

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**Cover.**—A silver or coho salmon, *Oncorhynchus kisutch*, returns to its Pacific Northwest cradle stream. This is one of several species of Pacific salmon considered for introduction to New England in the three-paper series "Salmon For New England Fisheries," beginning on page 1.

**U.S. DEPARTMENT OF COMMERCE**  
Frederick B. Dent, Secretary

**NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION**  
Robert M. White, Administrator

**National Marine Fisheries Service**  
Robert W. Schoning, Director



Address correspondence to: Marine Fisheries Review, NMFS Scientific Publications Staff, Room 450, 1107 N.E. 45th St., Seattle, WA 98105.

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*Keyed to ocean temperature regimes,  
Pacific salmon may replace  
the seriously depleted Atlantic  
salmon in New England.*

## Salmon for New England Fisheries

### Part I: Historical Background

TIMOTHY JOYNER

#### INTRODUCTION

The shallow ocean waters over the broad northeastern shelf and slope of the North American continent support an abundance of marine life — an important source of food for human populations bordering the North Atlantic Ocean. The richness of the salmon resources were appreciated by the first Europeans likely to have set foot on North America.

The American historian, Samuel Eliot Morison (1971), drawing from information in the *Groenlendina thattr* (Tale of the Greenlanders) in the Flateyar-bok (Flat Island Book) compiled by Jon Thórhðarson in 1387, gives an account of the Norseman Leif Ericson's short-lived settlement in 999 or 1,000 A.D. The location of this settlement has recently been placed at l'Anse aux Meadows near Cape Bauld at the northern tip of Newfoundland (Ingestad, 1964). The saga tells how the Norsemen were impressed by the abundance and size of the salmon in the river and lake at the site. They

were, in Morison's words, "... bigger salmon than they had ever seen."

By the beginning of the 16th century, John Cabot, after his first voyage to North America, reported a great abundance of cod in the waters he had explored. This report did much to stimulate the interest of northern Europeans in later explorations and colonization (de Loture, 1949). A few decades after Cabot, Jacques Cartier, a master mariner from Brittany, conducted extensive explorations of the northeastern coast of North America for France. He corroborated Cabot's observation about the cod and, having a Frenchman's high regard for gastronomic delights, he also carefully noted that the waters of Chaleur Bay teemed with salmon as he explored the western part of the Gulf of St. Lawrence in the summer of 1534 (Morison, 1971).

Although its commercial value has been minor relative to cod, flatfish and herring, the Atlantic salmon, *Salmo salar*, has been held in high esteem by people on lands bordering the North Atlantic Ocean. From the middle ages, and indeed into modern times, fishing for salmon in Europe had been largely the special preserve of royalty and of a privileged aristocracy. The rapid decline in the abundance of salmon along the coast of France at the end of the 18th century has been attributed

to overfishing by an eager public when restrictions on the taking of the king's fish were abolished in the wake of the Revolution of 1789 (Centre Nation pour l'Exploitation des Océans, 1972).

In the countries bordering the North Sea, industrialization has taken a heavy toll of salmon, even at considerable distances from industrial centers. Atmospheric pollution emanating from the industrial valleys of northern Europe and the British Midlands is carried by winds to generate acid rains over Norway. In the south of that country, where the bed rock is

#### EDITORIAL NOTE

During the past year the staff of the National Marine Fisheries Service's Division of Coastal Zone and Estuarine Studies at the Northwest Fisheries Center, Seattle, has considered the problem of increasing the yield of salmon from New England waters. This is the first of a series of three papers on the subject. Parts II and III, which follow, deal with the Effect of the Ocean Environment on the High Seas Distribution of Salmon, and Developing a Coastal Fishery for Pacific Salmon.

Timothy Joyner is Aquaculture Program Manager for the Division of Coastal Zone and Estuarine Studies, NMFS Northwest Fisheries Center, Seattle, WA 98112.

granitic and has little buffering capacity, surface waters become too acid for the successful incubation of salmon eggs (Berg, 1972).

Throughout colonial times in New England, salmon—which had for thousands of years provided seasonal food for Indians—remained abundant. During the 19th century, however, industrial development of the region brought about the damming and pollution of many of the rivers and streams that served as spawning grounds. This, coupled with overfishing, probably led to the depleted state of salmon stocks in New England today.

Now there are only small remnants of the stocks of Atlantic salmon which once spawned in streams around the entire rim of the North Atlantic Ocean—from the Arctic southward to the Connecticut shore and to the Iberian Peninsula on the other side. Of these remnants, most are found in the sparsely populated, northern parts of the region. As these remaining stocks are highly prized, the recent development of commercial fishing for Atlantic salmon on the high seas off southwest Greenland and in the Norwegian Sea has become a highly controversial issue in international fisheries management.

### IMPROVING SALMON FISHERIES IN THE ATLANTIC

There are two possible approaches to the problem of increasing the salmon stocks of the North Atlantic: (a) the development of systems for improvement of freshwater habitats and for increasing the survival and geographic range of native stocks of Atlantic salmon, and (b) the transplanting of stocks of Pacific salmon, *Oncorhynchus* spp. to the Atlantic region. In a 1954 paper, Ricker discussed their relative merits. He argued with respect to the first that such measures as bird control, opening up of new nursery grounds by fishways, continuous arti-

ficial propagation, better spawning escapements, etc., were worthy and should be intensified but that even the most optimistic could not expect that they could "... do more than double or triple the supply of salmon on the Atlantic coast as a whole in any foreseeable future." He reserved his most favorable arguments for the second approach. He pointed out the far greater abundance of salmon in the North Pacific Ocean than in the North Atlantic Ocean as reflected in the comparative Canadian catch statistics for 1948 (roughly 150 million pounds from the Pacific vs. 5 million from the Atlantic). He ascribed the difference to the fact that "... the two most numerous Pacific salmon live in rivers only during spawning and incubation periods and do not require the freshwater food or living space which appears to limit the supply of Atlantic salmon." Addressing himself to a Canadian readership, he suggested that it would be in the national interest to develop an inshore anadromous fishery in which Canada would have a proprietary interest to insure it against the day when its "... eastern offshore banks will be so continuously scoured by the trawls of competing nations that good quality bottom fish can no longer be taken in paying quantities." He went on to suggest that transplants of pink, *O. gorbuscha*, and chum salmon, *O. keta*, from the west coast would be the best approach to generating such an inshore fishery.

Prior to the publication of Ricker's (1954) paper, there had been several attempts to introduce Pacific salmon to the Atlantic coast. Pink and coho salmon, *O. kisutch*, had been planted in Maine, and chinook salmon, *O. tshawytscha*, in Lake Ontario streams and in New Brunswick. Permanent runs from these plants did not become established, although in Maine, small returns did occur for several cycles. At that time, the only successful, self-perpetuating runs of Pacific salmon transplanted from their natural habitat were the chinook salmon which since 1905 have become established in the

Waitaki and other rivers of the South Island in New Zealand (Davidson and Hutchinson, 1938).

### USSR TRANSPLANTS OF PACIFIC SALMON TO ARCTIC EUROPE

From 1956 to 1961, mass transplants (4 to 46 million) of the roe of pink and chum salmon were made from USSR fish culture stations on Sakhalin Island in the northwestern Pacific Ocean to stations in the Murmansk area on the Arctic coast of Europe. In 1960, 300,000 adult pink salmon returned to the rivers of that area. Smaller numbers appeared along the coast of Norway as far south as Bergen and along the coasts of Iceland and Great Britain. These runs subsequently dwindled. Rass (1965) suggests that roe from the spawning of transplanted adults had died from low temperatures in the rivers during the incubation period, the weather being colder at that time on the Murman Coast than on Sakhalin Island to which the fish were adapted.

### U. S. TRANSPLANTS OF PACIFIC SALMON IN NEW ENGLAND

During the past 6 years, fishery management agencies in several of the New England states have made modest plants of coho salmon (Figure 1) in an attempt to generate runs of these fish into their rivers. The eggs were from Washington and Oregon and reared at trout hatcheries in New England. The efforts of Connecticut and Rhode Island agencies have proved futile; no returns to the home rivers from any of the plants by these two states have ever been achieved. New Hampshire, on the other hand, has had returns (estimated at 3 percent in 1972) to the Exeter and Lamprey Rivers, which flow into Great Bay, and is seeing the beginning of a small salt-water sport fishery in that bay. In New Hampshire in the fall of 1972,

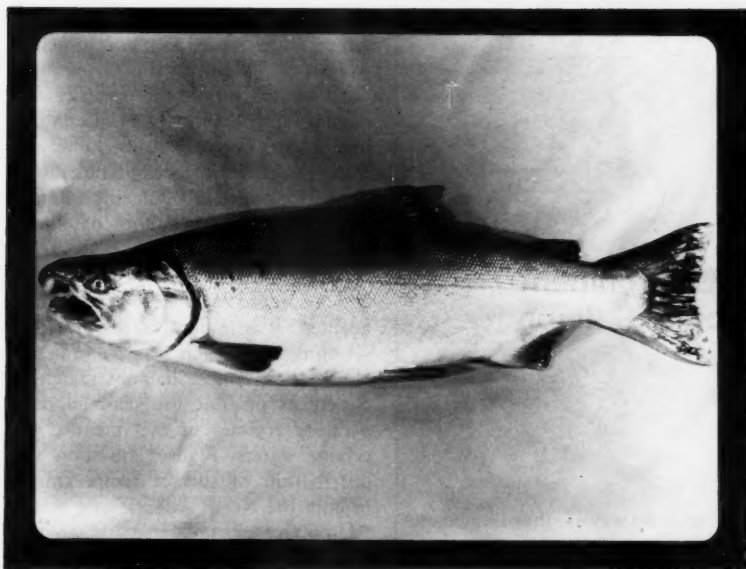


Figure 1.—The coho salmon is a possibility for the New England salmon sport fishery.

over 1,000 adult coho from a Columbia River stock planted in 1970 returned and 200,000 eggs were taken. These will be incubated in state hatcheries with 350,000 coho eggs from the Green River Hatchery in Washington. As development of self-sustaining, naturally-spawning runs of coho salmon into Great Bay is not considered feasible, New Hampshire biologists are focusing on hatchery production. A new state hatchery, primarily for the production of coho salmon, is being constructed at Milford, N.H., with funding assistance from the National Marine Fisheries Service.

New Hampshire coho salmon have been appearing in the estuary of the Merrimack River in Massachusetts, where a number have been caught by

sport fishermen. The Commonwealth of Massachusetts has also recently begun a modest effort of its own to establish coho salmon in the North River just to the south of Boston. Of 60,000 Green River (Washington) coho planted in the spring of 1971, personnel of the Division of Fish and Game of the Massachusetts Department of Natural Resources recovered 178 spawners returning to the North River in the fall of 1972. The weight ranged from 3 to 12 (avg. 7) pounds. Of the 130,000 eggs taken from these returning spawners, 90 percent hatched successfully and the fry are now being reared for future planting. During the summer before the spawning run, there were incidental catches of coho in the ocean off the North River by both

sport and commercial fishermen.

In these recent attempts to transplant Pacific salmon to New England, the success of the New Hampshire experiment and encouraging early returns from Massachusetts contrast with the stark failures experienced in Connecticut and Rhode Island.

The next article, Part II, will show how these results have reflected how well the timing of the homing migration of these fish was matched with the seasonal changes in the ocean environment off New England.

## LITERATURE CITED

- Berg, M. 1972. Lecture at the College of Fisheries, University of Washington, Seattle, November 24, 1972. [Unpubl. report.] Centre National pour l'Exploitation des Océans. 1972. Publication d'un "livre blanc" sur "Le Saumon, richesse bretonne à développer" par l'APPSB (Association pour la Protection et la Production du Saumon en Bretagne et Basse-Normandie). Centre Natl. Exploit. Océans, [France], Bull. CNEXO 42: 10-11.
- Davidson, F. A., and S. J. Hutchinson. 1938. The geographic distribution and environmental limitations of the Pacific salmon (genus *Oncorhynchus*). U.S. Bur. Fish., Bull. 48: 667-692.
- Ingstad, H. 1964. Vinland ruins prove Vikings found the New World. Natl. Geogr. Mag. 126: 708-734.
- Loture, R. De. 1949. History of the great fishery of Newfoundland. [In French.] Librairie Gallimard, Paris. (Engl. transl. by C. C. Taylor, 1957, U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 213, 147 p.)
- Morison, S. E. 1971. The European discovery of America, the northern voyages A.D. 500-1600. Oxford Univ. Press, N.Y., 712 p.
- Rass, T. S. 1965. Rybnye resursy Evropeiskikh morei SSSR i vozmozhnost' i ikh popoleniya akklimatizatsiei (Fish resources of the European seas of the USSR and opportunities to replenish them by acclimatization). Moscow, Izd. Akad. Nauk SSSR, 108 p. (Translated by Israel Program Sci. Transl., 1969; available U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA, as JPRS 48538.)
- Ricker, W. E. 1954. Pacific salmon for Atlantic waters? Can. Fish. Cult. 16: 6-14.

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*Though it appears homogeneous,  
the ocean is a changing,  
and limiting, environment  
for the Pacific salmon.*

## Part II: Effect of the Ocean Environment on the High Seas Distribution of Salmon

TIMOTHY JOYNER

### INTRODUCTION

To most human travellers on the high seas, ocean water appears pretty much the same from place to place. It is salty, which distinguishes it from drinking water. In the tropics, it tends to be warm and to appear deep indigo in color. As one approaches the poles, it tends to become cold and to appear gray-green if it has not solidified to ice. Outside of these features, there is little to distinguish one part from another.

To an oceanographer, the same features absorb his interest. He takes the additional steps of measuring its salinity, its temperature, and the way it absorbs and reflects light. He may go further and measure such things as the specific gases and solid substances dissolved or suspended in it and identify the living creatures that can be screened out of it. His outlook is objective, as he is secure in his thick-skinned, warm-blooded, ship-buoyed, galley-fed independence of the properties he is measuring. They interest

him, but in no way are they immediately significant to his vital processes.

A salmon, thin-skinned, cold-blooded, and hungry, experiences the ocean directly, intimately, subjectively. Uninsulated, unsupported, and self-fed, its vital processes are quickly affected by changes in the properties of the ocean waters in which it is immersed.

The vital processes of living things are driven by energy derived from chemical reactions taking place within their cells. Unlike those taking place in the heated retorts of chemical laboratories, these reactions proceed at low temperatures and pressures. This happens because of enzymes, chemicals that bring the components together so aligned that reaction can proceed without a boost from a great deal of heat and pressure. Enzymes produced by living creatures are uniquely suited to functioning under the special conditions imposed by the environment on the creatures which have adapted to them.

### TEMPERATURE AND OXYGEN

Salmon, like other cold-blooded marine vertebrates, are restricted to a narrow range of temperatures within which their vital processes can function. Dissolved oxygen is also essential.

Unless a salmon is within its allowable temperature range and has sufficient oxygen, it will quickly die. Given these gross limits, parts of the ocean can be readily identified in which salmon can live. Table 1 gives the tolerable and preferred ranges of ocean temperature for various species of Pacific salmon, *Oncorhynchus* spp. Within the range for each species, there is a spectrum of narrower temperature bands to which specific races of the species are adapted. It is important, therefore, in selecting stocks for transplanting, to choose races whose habitats match as closely as possible the seasonal temperature regimes of the intended receiving waters. Figures 1-3 show the distribution of surface temperatures, in both the North Atlantic and North Pacific Oceans, favorable for temperate-zone races of salmon. It might appear that surface temperature distributions present only a small part of the picture in the oceans' three dimensions. However, there are clues which lead us to suspect that the world of the salmon in the ocean is a rather thin layer close to the surface. The first of these comes from physiology: the air bladder of the salmon is open; air can be gulped in and burped out. This is the usual case with fish that do not venture too far from the surface. Fish that live at great depths and do not normally come to the surface usually have closed bladders into which gas is secreted from the blood for buoyancy control. A second clue comes from the vertical structure of ocean waters

Table 1.—Tolerable and preferred sea-surface temperatures for Pacific salmon.

Species	Tolerable Range °C	Preferred Range °C	Reference months for preferred range
Sockeye <sup>1</sup>	1-15	2, 3-9	May, September
Chum <sup>1</sup>	1-15	2, 3-11	May, September
Pink <sup>1</sup>	3-15	4-11	May, June
Coho <sup>1</sup>	5-15	7-12	May, June, July
Chinook <sup>1</sup>	2-13	7-10	July, August, September
Cherry <sup>2</sup> (masu)	5-15	7-12	March, April, May

<sup>1</sup>Source: Monzer, et al., 1965.

<sup>2</sup>Source: Tanaka, 1965.

Timothy Joyner is Aquaculture Program Manager for the NMFS' Division of Coastal Zone and Estuarine Studies, NMFS Northwest Fisheries Center, Seattle, WA 98112.

characteristic of arctic and subarctic regions. In the North Pacific, there is a layer of water, within several hundred meters of the surface, which is colder (at 3-4°C, or 37-39°F) in the summer than the water above and below. Its significance to the distribution of salmon was first considered by Favorite (1969b) who reported that its southern limit coincided with the southern limit of salmon distribution in the central part of the ocean in the summer. I would like to suggest, since the temperature of this layer is at the lower end of the range preferred by Pacific salmon and occurs at depths where the level of dissolved oxygen is characteristically low, that the layer could serve as a summertime floor for the salmon environment in the central North Pacific Ocean. A third clue stems from the observation that practically all of the salmon caught in floating drift nets fishing at varying depths from the surface are caught within 10 meters of the surface (Fukuhara, 1953). However, this observation may be deceiving because, as Favorite pointed out, salmon sensing a net dead ahead would try to avoid it. Those sounding would be able to swim under it, those veering to the right or left would eventually swim around it, while those veering upward would tend to become enmeshed near the surface.

What about the other properties that oceanographers (and astute fishermen and submariners) use to distinguish ocean waters—of what significance may they be to salmon?

## SALINITY

As far as its vital processes are concerned, the salt content of its environment is crucially important only during the juvenile stages of a salmon's life. Its eggs require fresh water for incubation, and the young salmon can tolerate salt water only after the kidney has developed enough that it can hold a proper balance of salts between the blood and body fluids inside and the salt water outside of the fish. With

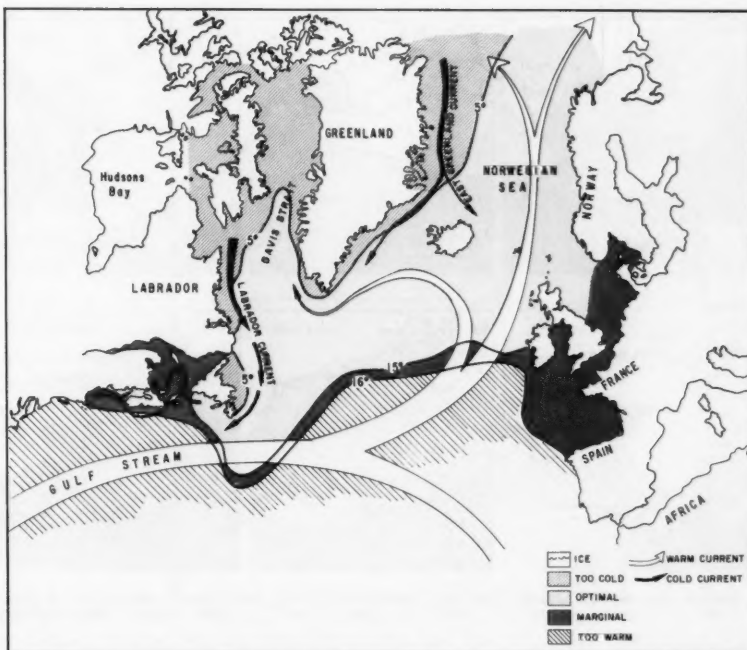


Figure 1.—North Atlantic environment for temperate zone salmon—summer sea-surface temperatures (°C). Adapted from Naumienko et al., 1968.

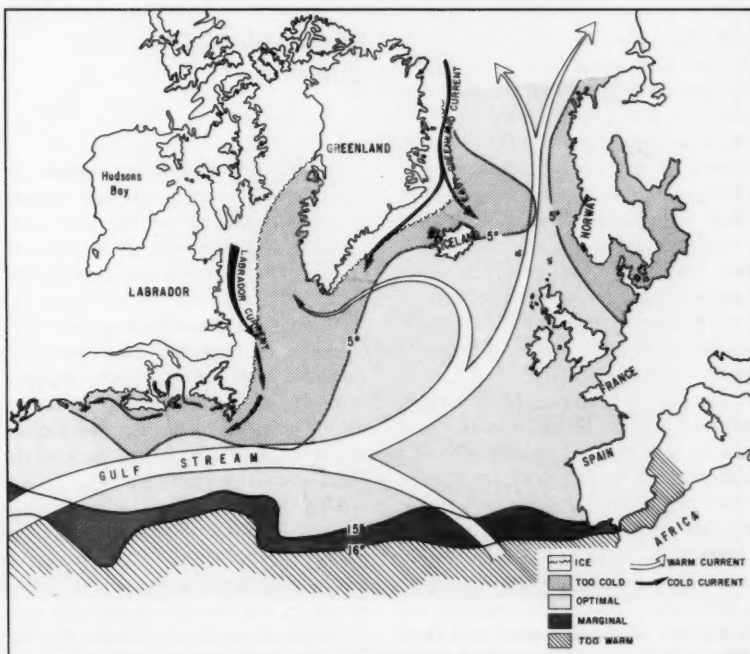


Figure 2.—North Atlantic environment for temperate zone salmon—winter sea-surface temperatures (°C). Adapted from Naumienko et al., 1968.

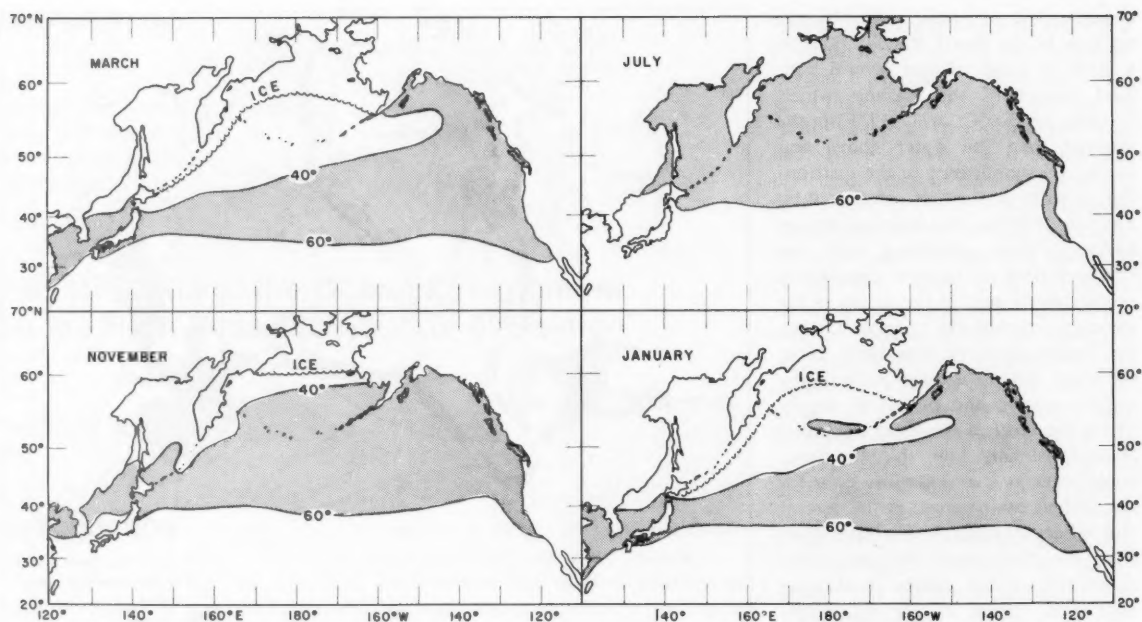


Figure 3.—North Pacific environment for temperate zone salmon—seasonal sea-surface temperature (°F). Adapted from U.S. Naval Oceanographic Office, 1969.

pink, *O. gorbuscha*, and chum salmon, *O. keta*, this occurs early and the young fry can go directly into the sea. With coho, *O. kisutch*, Atlantic, *Salmo salar*, and cherry salmon, *O. masu*, the kidney is not ready to assume this function until the fry have grown to be large fingerlings. This usually takes more than a year. In any case, by the time a salmon has migrated to the sea, salinity does not seriously affect its vital processes. This is not to say that it does not affect where the salmon goes—only that the life of the fish is not jeopardized by changes in salinity between ocean water masses. That salinity can play a powerful role as a signpost in the migration of salmon from the ocean back to their home streams has been discussed by Favorite (1969a). Also, as the primary factor controlling the density of sea water, it profoundly affects the structure and movement of ocean waters and thus, indirectly, the distribution of temperatures and the location, direction, and speed of currents.

## FOOD AND OCEAN CURRENTS

Within the boundaries defined by the ranges of temperature and oxygen saturation essential to the vital processes of salmon, the abundance of food and the location and direction of ocean currents must be the chief remaining determinants of salmon distribution on the high seas. From the point of view of a salmon, once a suitable environment has been established, enough food must be found, and it must be able to get back to its home stream for spawning.

The location of plankton and small fish that serve as food for salmon on the high seas is largely related to ocean circulation. Their abundance is determined by the amount of sunlight and of chemical nutrients available for the growth of the single-celled plants at the bottom of the food chain. Where wind-driven surface currents move

offshore, upwelling replaces the surface waters with nutrient-rich deep water. Plankton growing in this enriched medium move with the surface currents and tend to be concentrated along the edges and in the marginal vortices that split off from the currents. What oceanographers describe as "patchiness," therefore, characterizes the distribution of plankton in the ocean. Fish such as salmon, which feed on plankton and smaller fish, will seek areas where the plankton are concentrated, much as hunters on the land will seek water holes and grazing meadows where their prey are likely to congregate. Thus, as the game trails of the forests and the plains serve the hunting cats, so are ocean currents likely to lead the predatory salmon to their sources of food. They are likely, also, to help guide the salmon back to the rivers and streams where they were spawned so that they may, in turn, spawn the next generation. Favorite (1969c, 1970) has detailed what is known about ocean circulation and

the abundance of food in the North Pacific Ocean as it relates to the distribution of sockeye salmon, *O. nerka*.

## TRANSPLANTING PACIFIC SALMON TO THE ATLANTIC

In Part I of this series, I noted the attempts in the USSR to establish pink salmon (from Sakhalin Island in the northeastern Pacific Ocean) in the rivers of the Murman Coast of Europe and the recent U.S. efforts in New England to develop runs of coho salmon. Rass (1965) proposed that the failure of the USSR transplants of 1956-61 to establish substantial self-sustaining runs, despite the spectacular returns of 1960, stemmed from a mismatch of the river temperatures on the Murman Coast with those of Sakhalin Island, home of the parent stock, during the period of egg incubation.

Ricker (1954) discussed the failure of Canadian efforts to transplant chinook salmon, *O. tshawytscha*, to Lake Ontario streams and to New Brunswick. Stating that "... the chinook is the least common salmon in the Pacific and, apart from the sockeye, the most choosy one in respect to the stream that it ascends..." he felt that it was not surprising that these efforts failed. Addressing himself generally to the matter of transplanting Pacific salmon stocks, he suggested two desirable characteristics for any program of transplantation:

1. "Relatively large plantings should be made to one or a few sites, at first, so that there will be an adequate expendable surplus while the selection process is weeding out genes whose effects are in poor adjustment to the new situation..."
2. "Donor stocks should be carefully selected in order to match up the freshwater and marine conditions of existence of the old and the new sites as closely as possible."

Ricker was concerned primarily with the establishment of self-sustaining runs of naturally-spawning Pacific

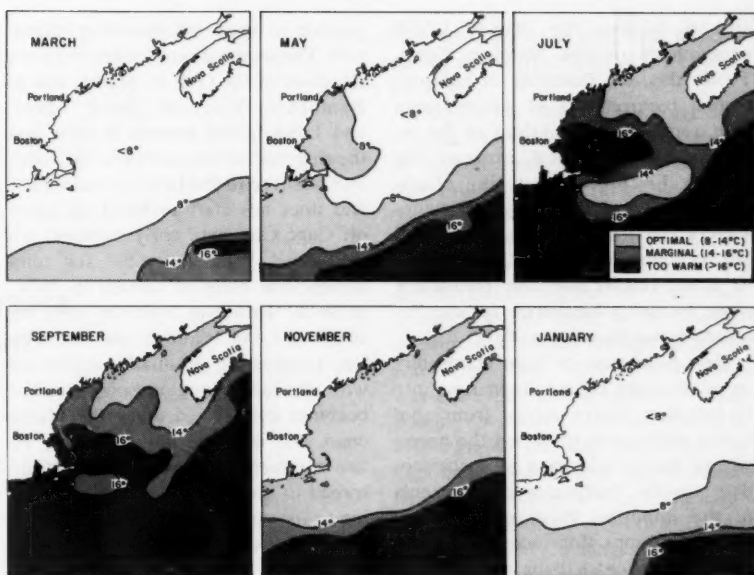


Figure 4.—Sea-surface temperatures in the Gulf of Maine suitable for Pacific Salmon (°C). Adapted from Colton and Stoddard, 1972.



Figure 5.—Boundary between cold Labrador-type water (lighter color) and the warmer Gulf Stream influenced water (darker color, below) in November. Salmon would be confined to the lighter colored cool waters at this time. This photograph, taken from the NOAA-2 satellite, corresponds generally to the November temperature structure indicated in Figure 4.

salmon, as were the 1956-61 USSR experiments on the Murman Coast. To do this, the matching of environmental requirements of donor stocks with appropriate conditions in the receiving waters is critical. However, the urgency for precise matching of environmental conditions can be somewhat relaxed if some of these conditions can be controlled artificially. This can be done readily for the freshwater phase by using hatcheries for egg incubation and the rearing of fry.

Recent success in New Hampshire in establishing coho salmon runs into Great Bay partly stems from that state's willingness to accept the necessity of hatchery rearing to accommodate to the freshwater requirements of the imported Washington stocks. The conditions for ocean survival, however, still had to be met. In this, New Hampshire has been fortunate, in contrast to Rhode Island and Connecticut. These states failed in attempts to establish runs of coho salmon from Oregon and Washington into Block Island and Long Island Sounds although they used much the same hatchery techniques for incubation and rearing as employed in New Hampshire. The seasonal sea-surface temperature structure of the Gulf of Maine (Figures 4 and 5) suggests an explanation for these contrasting results. In the summer and early fall, a temperature front extends eastward from Cape Cod to the Gulf Stream. Temperatures in excess of 16°C (61°F) occur south of the front which would block the return of fall-spawning coho salmon to rivers and streams south and west of the Cape. North of the Cape, however, there would be little to prevent their moving into estuaries from the cool offshore waters in the late summer and early fall as a

prelude to their fall spawning migration. The seasonal, surface-temperature structure of the Gulf of Maine, and of Nantucket, Vineyard, Block Island, and Long Island Sounds is such that the thermal barrier moves to the south and offshore in the late fall and winter and does not start to build up again off Cape Cod until early summer. An isothermal band favorable for temperate-zone races of salmon (8-14°C, or 46-57°F) moves from the open sea south of Long Island in the late winter, progressing gradually northward with the advancing seasons, until it becomes compressed along the Maine coast and into the Bay of Fundy by late summer. By the fall, it begins to spread to the south, eventually returning to its wintertime position offshore, south of Long Island. This suggests that Pacific salmon, planted in New England, would be found in ocean waters off the coast of Maine and in the Bay of Fundy in the summer, where they should be accessible to both sport and commercial fishermen. They would tend to move with the southward spread of 8-14°C water and, if chosen from stocks appropriately selected for the timing of their migrations back to fresh water, would appear off their home streams when the 8-14°C band was in a favorable position offshore.

From the foregoing, it seems likely that the early fall-running coho salmon was a poor choice for establishing runs of Pacific salmon in Rhode Island and Connecticut. A late fall-running stock might have had better success. It also appears that spring-running stocks of chinook salmon, cherry salmon and steelhead trout, *Salmo gairdnerii*, should be able to migrate from the ocean into streams flowing into Block Island and Long Island Sounds.

Systems for introducing appropriately selected stocks of Pacific salmon thereby generating new sport and commercial fisheries on the coast of New England will be proposed in the concluding paper in this series.

## LITERATURE CITED

- Colton, J. B., and R. R. Stoddard. 1972. Average monthly sea-water temperatures, Nova Scotia to Long Island, 1940-1959. Ser. Atlas Mar. Environ., Am. Geogr. Soc. Folio 21, 10 pls.
- Favorite, F. 1969a. Fishery oceanography—II. Salinity front at entrance to Washington's Strait of Juan de Fuca. Commer. Fish. Rev. 31(9):36-40.
- 1969b. Fishery oceanography—III. Ocean temperature and distribution of Pacific salmon. Commer. Fish. Rev. 31(10):34-40.
- 1969c. Fishery oceanography—V. Ocean circulation and distribution of sockeye salmon. Commer. Fish. Rev. 31(12):35-39.
1970. Fishery oceanography—VI. Ocean food of sockeye salmon. Commer. Fish. Rev. 32(1):1-17.
- Fukuhara, F. M. 1953. North Pacific salmon-fishing expedition. Commer. Fish. Rev. 15(2):1-17.
- Manzer, J. I., T. Ishida, A. E. Peterson, and M. G. Hanavan. 1955. Salmon of the North Pacific Ocean—Part V. Offshore distribution of salmon. Int. North Pac. Fish. Comm., Bull. 15, 452 p.
- Naumienko, T. (chairman) 1968. Pergamon world atlas. Pergamon Press, Ltd., Oxford, and Polish Sci. Publ., Warsaw, p. 63-65, 69.
- Rass, T. S. 1965. Rybnye resursy Evropeiskikh morei SSSR i vozmozhnost' i ikh popoleniya akklimatizatsiei (Fish resources of the European seas of the USSR and opportunities to replenish them by acclimatization. Moscow, Izd. Akad. Nauk SSSR, 108 p. (Translated by Israel Program Sci. Transl., 1969; available U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA, as JPRS 48538.)
- Ricker, W. E. 1954. Pacific salmon for Atlantic waters? Can. Fish. Cult. 16:6-14.
- Tanaka, S. 1965. Salmon of the North Pacific Ocean—Part IX. Coho, chinook and masu salmon in offshore waters. 3. A review of the biological information on masu salmon (*Oncorhynchus masou*). Int. North Pac. Fish. Comm., Bull. 16:75-135.
- U. S. Naval Oceanographic Office. 1969. Monthly charts of mean, minimum and maximum sea surface temperature of the North Pacific Ocean. Spec. Publ. 123, p. 6, 8, 12, 16.

MFR Paper 1009, from Marine Fisheries Review, Vol. 35, No. 10, October, 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.

*A modest hatchery program combined with saltwater rearing should generate a vigorous New England salmon sport fishery.*

## Part III: Developing a Coastal Fishery for Pacific Salmon

CONRAD MAHNKEN and TIMOTHY JOYNER

### INTRODUCTION

An examination of history shows that the effects of the growth and spread of Western civilization on the inshore fisheries have been disastrous. And today, even on the high-seas fisheries, its effects are becoming all too clearly evident.

Perhaps saddest of all has been the fate of the Atlantic salmon, *Salmo salar*. For centuries, salmon stocks which had flourished under the protection of royal decree in the preindustrial kingdoms of Great Britain and northern Europe, quickly disappeared as factories, sewers, and ship channels usurped their native habitats in the Thames, the Rhine, and the Scheldt. In France, overfishing proved equally detrimental. In the wake of the Revolution of 1789, an overeager population, freed of royal restrictions on the taking of salmon, destroyed the once considerable runs of the rivers flowing into the English Channel and the Bay of Biscay. On the western shore of the Atlantic, the story was much the same. The combination of habitat destruction and overfishing virtually eliminated the vast salmon resources which had been the delight of colonial Europeans in England and eastern Canada for two

centuries and of the Indians for thousands of years before that.

In the Pacific Northwest, the development of an extensive system of hatcheries and vigorous management of the fisheries has slowed the decline of Pacific salmon, *Oncorhynchus* spp., populations that began as soon as the western spread of European civilization started taking its inevitable toll of that region's vast resources. And now, new developments in the technology for rearing Pacific salmon hold forth the promise that at last the historic trend can be reversed.

The first salmon hatchery on the Pacific Coast of North America was opened in 1872 on the McCloud River in northern California by the U.S. Fish Commission. From this simple beginning, salmon hatcheries in the Pacific Northwest have become the most highly developed of modern aquatic culture systems. Information on disease, nutrition, growth energetics, physiology, behavior, and life history—resulting from research at salmon laboratories—is plentiful and has been used as a starting point for research on other species of fish as well. In the State of Washington, hatcheries are operated by both the State and Federal governments. The first hatchery in the

State was opened in 1895 near Kalama on one of the tributaries of the Columbia River.

Despite the development of extensive hatchery systems for rearing Pacific salmon from eggs to fingerlings, mortalities from natural causes during their downstream migration and at sea can be enormous. Added to this are increasing pressures from sport and commercial fishing. Recently, however, a significant advance in the culture of salmon has been brought about by extending their confinement. This was achieved by holding them in pens floating in saltwater so that instead of migrating to the sea, they could be kept under control from egg to maturity. Saltwater pen culture is the latest of several important steps in the evolution of hatchery management starting with the fry-release systems of early hatcheries. Following is a review of traditional and newly developed salmon culture systems in use on the Pacific Coast and a plan for applying some of them to the introduction of Pacific salmon in New England.

### HATCHERY REARING SYSTEMS

At first, hatchery rearing extended only through the early fry stage when the tiny salmon were released into the streams. In 1895, the first year of operation of the Kalama hatchery, more than 4 million fry were planted. By the 1930's, as many as 189 million eggs were being taken for fry propagation (Washington Department of Fisheries, 1968).

At salmon hatcheries, the period of rearing has been gradually extended before the young salmon are released to migrate downstream to saltwater.

**NMFS fisheries scientists Conrad Mahnken and Timothy Joyner, at the Northwest Fisheries Center, Seattle, Washington, have studied the Pacific salmon fisheries potential in New England during the past year.**

Larger migrants are better able to cope with environmental hazards enroute to the sea and tend to return at a higher rate than earlier-released fry.

In 1970, the Washington Department of Fisheries planted more than 34 million large fingerling smolts. In addition, 80 million smaller fingerlings and nearly 12 million fry were planted (Washington Department of Fisheries, 1970). The high percentage of adult coho salmon, *O. kisutch*, of hatchery origin in Puget Sound sport and commercial catches (estimated at 40% in recent years) attest to the success of such programs. In 1972, an unusual year, 90% of the sport and commercially caught coho returning to home streams in Puget Sound were estimated to have been reared at hatcheries. The progressive loss of natural habitat places increasing demands on hatcheries to maintain valued stocks of fish.

In modern Northwest hatcheries, extended rearing is being applied to the rearing of coho salmon which, in 1970, made up more than 30% of the salmon released in the State of Washington.

Adult coho spawn in the fall and early winter. The juveniles remain in fresh water for a year or more before migrating downstream to the sea. Most coho mature in 3 years when, weighing between 2.7 and 5.4 kilograms (6-12 pounds), they return to their home streams to spawn (Hart, 1973). At the hatcheries, which substitute for their natural spawning environment, the salmon are reared on artificial diets in ponds or raceways until they are ready to go to sea 12 to 14 months after hatching.

Returning adults selected for spawning are killed. The eggs are stripped from the fresh carcasses and fertilized with sperm from selected males. The fertilized eggs are incubated in stacks of trays made of fiberglass or plastic. Water cascades from one tray to the next, welling upward around the eggs which are supported above the bottom of the tray by a screen, and flows over a lip into a channel along the edge

of the tray down to the next. Each stack of 16 trays can hold 100,000 eggs or fry. The eggs are extremely sensitive to handling for 3 weeks after fertilization. Then, when the eyes become clearly visible, the eggs may be handled without injury and, if desired, shipped considerable distances.

The hatching period is dependent on water temperature. At 11.1°C (52°F), it will take 45 days for the eggs to hatch; at 5.5°C (42°F), it will take 90 days. After hatching, the alevins are nourished from the material stored in the egg sac, which lasts for 5-6 weeks. The rate of absorption of the yolk is dependent on the water temperature. When the egg sac has been absorbed, the young fry begin to search for food. Once they begin feeding, they are shifted to tanks, troughs, and ponds or raceways where they will have more room to grow. In some of the outdoor rearing areas at the larger hatcheries, 500,000 or more fry can be accommodated in each pond or raceway.

This kind of system affords control only over the freshwater phase of the life of the fish. When the young coho grow to a size of 15 grams (0.48 ounce)—about 14 months after hatching—they are released into the streams to face the rigors of predation and competition for food. Mortality is high. In hatcheries, about 90% of the coho reach the fry stage and about 75% survive to become yearlings. By the time they return from the ocean as adults, only about 1% of the yearlings are left (Washington Department of Fisheries, 1968). Despite this low percentage of survival, hatchery runs are increasing. From recent research, we now know that survival to maturity is increased when the fish are held longer at the hatcheries so that they are larger when released. In 1961, an increase in the size at release from 13 to 27 grams (0.46 to 0.95 ounce) improved the return of adults from 0.47 to 2.81% (Washington Department of Fisheries, 1968). Lack of additional space and water, however, would make it difficult to extend the rearing of coho salmon at most hatcheries.

## SALTWATER REARING

At some state hatcheries in the Pacific Northwest, returning adults provide more eggs and sperm than are needed to maintain full production. These surpluses make it possible for private growers to purchase seed from the states for commercial sea farms or feedlots in which salmon are grown to pan size in floating pens made of netting. In such a system, the tide-driven flow of saltwater carries in fresh oxygen and carries out waste. The temperature of the water should be high enough to promote the efficient conversion of feed, yet low enough to prevent the proliferation of disease. For coho the best range of temperature is between 9° and 15° C (48.2° and 59.1° F), with an optimum at about 12°C (53.6°F).

Experiments at the National Marine Fisheries Service's Aquacultural Experiment Station at Manchester, Washington, on Puget Sound have shown that in saltwater pens it is possible to rear coho from 15 to 340 grams (0.53 to 12.0 ounces) in 6-8 months and to maturity in an additional 10-12 months, a full year ahead of fish reared and released at hatcheries (Mahnen et al., 1970; Novotny et al., 1971-72). During 1971-72, in a cooperative pilot experiment by the U.S. Department of Commerce and private industry, more than 200,000 pan-sized salmon were grown in 14 months. Freshwater growth was accelerated by heating the water at the hatchery and in the rearing ponds. Final growth was in a floating system of net pens (Figure 1).

## ACCELERATED FRESHWATER GROWTH

In an effort to reduce costs, commercial salmon farmers on the West Coast are using new methods to improve the growth of salmon in fresh water. Shortening the freshwater growing period by careful control of

water temperature has made possible economies in operations, maintenance, and labor. When the water is heated to 11.1-12.8°C (52-55°F), coho salmon will grow to 15-20 grams (0.48-0.64 ounces) in 8 months after hatching, compared to the 12-14 months at hatcheries where unheated water is used (Figure 2). Heated water systems also make it possible to stagger production for optimum use of hatchery space.

In Puget Sound, commercial growers have already begun selective breeding to improve their stocks. Rapidly growing salmon are selected for brood stock and kept in saltwater pens and fed special diets until they are ready to spawn, having lived out their entire lives in captivity.

## DELAYED RELEASE AND ITS EFFECT ON MIGRATORY BEHAVIOR

Delaying the release of hatchery-reared salmon is being tested in the State of Washington as a means of improving returns. These experiments have produced unexpected results. In the past, the young salmon have been released at a time to coincide with their normal seaward migration from their

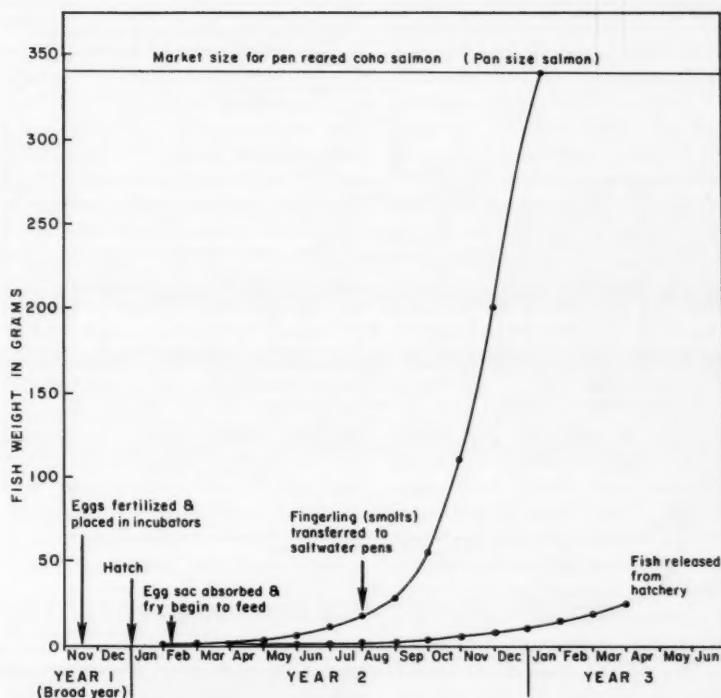


Figure 2.—A comparison of the early growth of coho salmon in normal and accelerated rearing systems.

home streams. Recent studies by the Washington Department of Fisheries have shown that delaying their release alters the normal migratory behavior.

Continuous and extraordinarily high catches in the Puget Sound sport and commercial fisheries of "delayed-release" salmon show that these fish tend to remain near the site of release instead of migrating out to sea. The same sort of behavior results when salmon are delayed in saltwater pens beyond the time of their normal out-migration before being released. Not only do the salmon remain relatively close to the release site, but the mature fish run up streams in the vicinity of the site rather than returning to the hatchery stream to spawn (Figure 3). At the National Marine Fisheries Service's Experiment Station at Manchester, salmon have returned to Clam Bay on central Puget Sound where they had been held in saltwater enclosures before they were released. The mature fish ran into Beaver Creek, a stream that flows into Clam Bay, rather than to their hatchery stream at Minter Creek on southern Puget Sound.

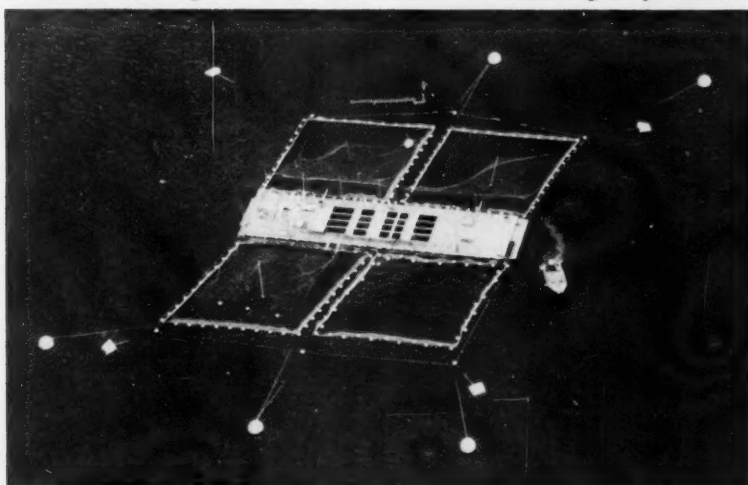


Figure 1.—Floating system of net pens used to rear coho and chinook salmon in Puget Sound (more than 200,000 pan-sized salmon were harvested from these four pens).

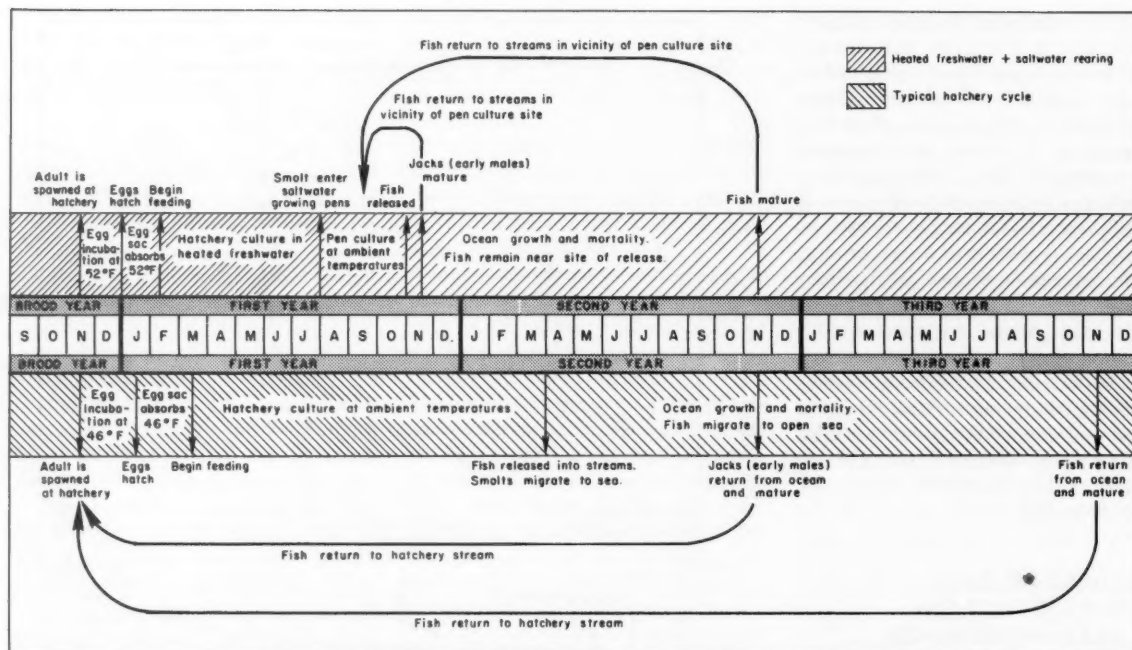


Figure 3.—A comparison of the life cycles of coho salmon in normal and accelerated rearing systems.

Delaying the release of young salmon, then, has the following advantages over normal hatchery procedures:

1. They tend to remain in the immediate locality and stay available to local fishermen.
2. When they are held in saltwater before being released, they do not return to the hatchery stream to spawn but move instead to a suitable stream near their point of release.
3. Survival to maturity is increased, with improved escapement and returns to sport and commercial fisheries.

The application of delayed rearing techniques should make it possible to manipulate migration patterns by inducing salmon to return to selected homing stations.

## A PLAN FOR NEW ENGLAND

The streams of New England once teemed with Atlantic salmon. In the rush to carve a nation from the wilderness, little heed was paid to fish so numerous that they were often used

as fertilizer. Fishing was unregulated, streams were dammed, and rivers were polluted by the wastes of industrial cities. As its freshwater environment deteriorated, the Atlantic salmon disappeared from most of its natural range. Today, there is growing concern for restoring the quality of the rivers and streams of New England, but it will take time. Over the past several decades, the efforts to re-establish natural runs of Atlantic salmon have not yielded much success.

Re-establishing large, natural runs of these fish, which are difficult to rear in hatcheries, will probably have to await the full rehabilitation of the rivers. Pacific salmon, however, are much easier to rear in hatcheries. With the new techniques for rearing hatchery-produced Pacific salmon in saltwater pens, the amount of freshwater rearing space for growing juveniles can be significantly reduced. A modest hatchery program combined with saltwater rearing should be able to produce enough Pacific salmon to

generate a vigorous sport fishery along the New England coast.

The matching of the environmental requirements of donor stocks with appropriate conditions in the receiving waters can be critical. By paying attention to the greater latitudinal shift of ocean temperatures with the seasons in the North Atlantic, introductions of Pacific salmon can be timed so that ocean conditions match those of the North Pacific. With the hotter summers and colder winters of New England, it will be more difficult to find appropriate freshwater conditions. However, the urgency for precise matching in this respect can be relaxed if the early rearing is done in hatcheries in which the water temperature can be controlled. The ground water in much of southern New England remains close to 11°C (52°F) the year round.

In such water, coho salmon could be reared from eggs in the fall to smolts ready to migrate by late spring or early summer when ocean temperatures off New England would be appropriate for them. The smolts could

Table 1.—Predicted growth for coho salmon in fresh water at Quinebaug hatchery and in saltwater pens in Plum Island Sound (see text).

Date		Avg water temp		Event	Body weight	
		°C	°F		Grams	Ounces
Nov	1	11.1	52	Eggs taken	—	—
Jan	30	11.1	52	Eggs hatched	—	—
Mar	11	11.1	52	Sacs absorbed	—	—
Mar	31	11.1	52		0.9	0.032
Apr	30	11.1	52		2.0	0.071
May	31	11.1	52		4.2	0.148
June	30	11.1	52		8.6	0.304
July	31	11.1	52		18.2	0.642
Aug	4	11.1	52	Fish to salt-	20.0	0.706
Aug	15	14.5	58	water pens	26.3	0.928
Aug	31	14.5	58		39.0	1.38
Sept	15	17.0	63		60.3	2.13
Sept	30	17.0	63		93.0	3.28
Oct	1	13.5	56	Fish released	131.4	4.64
Oct	31	13.5	56	Fish released	189.7	6.70

then be trucked to saltwater rearing stations north of Cape Cod where they could be held through the summer for additional growth before releasing them. In this way the saltwater stations would provide capacity for extended rearing without taking up additional hatchery space, improving the chances for increased survival at sea and conditioning the mature fish to home on streams near the release sites.

There are many bays and sounds between Cape Cod and the Bay of Fundy that would be suitable for saltwater rearing. One of these is Plum Island Sound in Massachusetts.

We have prepared a model based on a hypothetical system in which coho would be reared, first in fresh water at a temperature of 11°C and then transferred early in the summer to a rearing station in Plum Island Sound. The projected growth in such a system is shown in Table 1. Release of the fish from the saltwater pens in October would take advantage of summer temperatures in the Sound which would favor the production of large, vigorous fish with a high probability of ocean survival and which, when mature, would return to Plum Island Sound. Mature brood fish would go into the Ipswich and Parker Rivers, small streams that flow into Plum Island Sound, where they could be readily trapped and the spawn taken to an appropriate hatchery. With such a

system, a recreational fishery for Pacific salmon could be generated along the New England coast without the need for many large hatcheries or extensive natural river spawning.

Groundwater resources that can produce large volumes of water ideal for the accelerated freshwater rearing of salmon could be further developed in New England for use in hatcheries. The new State hatchery at Quinebaug in Connecticut is an outstanding example of how to build a fish-rearing facility around a superb source of ground water. The site of the new hatchery being built at Milford, N.H., was also chosen on the basis of a good source of ground water. Western Rhode Island has groundwater sources that have scarcely been tapped that would seem well-suited for the development of salmon hatcheries.

The geography of New England

suggests that a regional system might best serve the development of salmon fisheries. Such a system, as we envisage it, would include freshwater rearing facilities centralized in a few, well-designed, large-volume hatcheries, primarily in southern New England where groundwater temperatures are optimum for rapid freshwater growth. Smolts of fall-running coho, reared at these hatcheries, could then be transferred to homing stations along the coast from Cape Cod to Maine to be released after a period of holding in saltwater pens to condition them to home on nearby streams. Spring-running chinook, *O. tshawytscha*, (Figure 4) and cherry, *O. masu* salmon could be released into the estuaries of streams flowing into Vineyard, Block Island, and Long Island Sounds to provide a salmon fishery for southern New England in the spring when the ocean temperatures are favorable for their homing migration.

Based on the evidence that we have briefly touched on in this paper, we believe that development of such a regional system for rearing salmon in New England could lead to the establishment within a very few years, of a vigorous, inshore salmon fishery that would not be readily accessible to foreign fishing fleets.

Figure 4.—A chinook, largest of the U.S. Pacific salmon, returns to its hatchery.



## LITERATURE CITED

- Hart, J. L. 1973. Pacific fishes of Canada. Fish. Res. Board Can., Bull. 180, 740 p.
- Mahnken, C. V. W., A. J. Novotny, and T. Joyner. 1970. Salmon mariculture potential assessed. Am. Fish Farmer 2(1): 12-15, 27.
- Novotny, A. J., and C. V. W. Mahnken. 1971-72. Farming Pacific salmon in the sea: from the "womb to the tomb." Pt. 1 - Fish Farming Ind. 2(5):6-9; Pt. 2 - 3(1): 19-21.
- Washington Department of Fisheries. 1968. Salmon hatcheries, 18 p.
- . 1970. 1970 Annual Report. State Printing Plant, Olympia, Wash., 159 p.

MFR Paper 1010, from Marine Fisheries Review, Vol. 35, No. 10, October 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.

*Nightlighting, an ancient fishing technique, is updated to help 20th century fishermen concentrate fish for harvest.*

## A Self-Contained Subsurface Light Source System For Fish Attraction

DONALD A. WICKHAM and  
WILBER R. SEIDEL

### ABSTRACT

*A light source system is described which has potential for use in commercial fisheries utilizing nightlighting techniques for concentrating fish for harvest. Design criteria are provided for two prototype platform configurations of the system, a modified spar buoy and a catamaran. Each configuration is designed to meet operational requirements for specific types of potential fishing applications. At-sea operational field trials and evaluations of the prototype platform are discussed.*

### INTRODUCTION

Nightlighting techniques have been used to attract and concentrate fish for capture since ancient times (von Brandt, 1972). Light sources have evolved from hand-held torches to the gas- and electric-powered lamps used today. Fish attraction lamps are usually deployed by mounting them directly on the fishing vessel, drifting the lamps powered by battery or attached umbilical power cord away from the vessel on a float, or using portable gas- or electric-powered lamps in manned skiffs. These techniques impose disadvantageous restrictions on the activities of the fishing vessel when the lamps are in use. They limit the number of lamps and size of the area in which lamps from a single vessel

can be deployed or require an increase in manpower to support them.

As a result of our field experience in the development and evaluation of light attraction fishing techniques (Bullis and Thompson, 1967, 1970; Wickham, 1970, 1971a, 1971b, in press), we recognized a need for a self-contained, unmanned fish attraction light source which could be anchored, moved by power, or drifted freely without requiring close attention from a fishing vessel. A light source system of this type was also required for development of a netless harvesting system (Klima, 1970, 1971). The

**Donald A. Wickham and Wilbur R. Seidel are fishery biologists at the NMFS Southeast Fisheries Center, Pascagoula Laboratory, Pascagoula, MS 39567.**

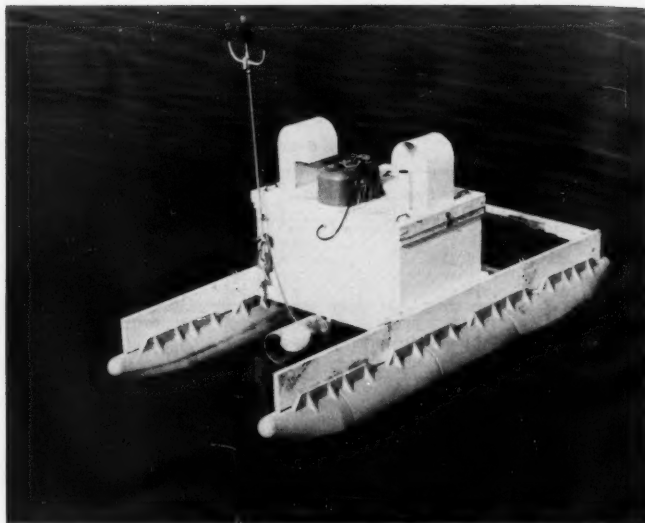


Figure 1.—The prototype unit of the catamaran configuration (FLAC). The attraction lamp swing arm can be seen in the "up" position between the pontoons.

National Marine Fisheries Service proposed this netless system as a potential approach to economically harvesting the estimated 4 million tons of latent coastal pelagic finfish resources in the Gulf of Mexico (Bullis and Carpenter, 1968). A desirable feature for a light source to be used with the netless harvesting system would be the capability for operation as a single unit or as one of a multiple series of units operated sequentially (Wickham, 1971b). Duncan (1952) patented an unmanned fishing lure for use with purse seines. This was an automatic chumming device with surface mounted lamps which could be used for fish attraction. Our self-contained light source system was conceptualized primarily for the attraction of fish with light. It employs an underwater lamp to eliminate light loss at the air-water interface, thereby maximizing the attracting range and effectiveness of the light source. The prototype units described in this report have been used to attract and control aggregations of mixed coastal pelagic fishes (i.e. sardine, herring, scad, anchovy, etc.) in concentrations

as large as 4.5 metric tons (10,000 pounds) during preliminary field trials in the northeastern Gulf of Mexico.

## SYSTEM DESIGN CONCEPT

Our basic design criteria for the self-contained, subsurface, fish attraction light source system was to provide a stable, buoyant platform containing an electric generator for powering an underwater fish attraction lamp and requisite supporting components. Two platform configurations of our light source system, a modified spar buoy (fish light attraction buoy—FLAB) and a catamaran (fish light attraction catamaran—FLAC), were designed to test operational requirements for specific fishing applications. These system configurations were built and tested in prototype form (Figure 1). Design considerations for both prototype configurations are presented in this report. Platform configurations different from the prototype models are possible within the basic system design, but all variations require the common components shown schematically in Figure 2.

The light source system was designed around a portable electric generator which supplies power to an underwater lamp and accessory support equipment. We used a gasoline-powered 2.5 kw, 115-volt a.c. generator, with an electric starter and battery charger, enclosed within a vented water resistant compartment.

Modifications to the generator to allow installation in a closed container were minor and involved mounting the manual start and kill switches externally, extension of the exhaust pipe to vent outside the enclosure, and attachment of a copper fuel line from the carburetor to an externally vented spill-proof fuel tank.

The externally mounted generator "on-off" indicator lamp and an a.c. enclosure ventilation exhaust fan are powered directly by the generator. The generator also supplies power to the a.c. switch-controlled fish attraction lamp.

A regulated battery charger on the a.c. generator was used to charge a heavy duty (i.e.,  $\geq 80$  ampere-hour) automobile-type storage battery. This storage battery supplies power to the system's d.c. components which include the safety flasher lamps, d.c. enclosure ventilation exhaust fan, and the starter for the generator motor. Our prototype systems were operated under manual control; however, an optional d.c. powered automatic timer or radio controlled switching unit could be included for remote operation.

The design concept of the light-source system will be further clarified by the illustrations of the FLAB and FLAC units (Figures 3 and 4) and the following brief functional description of each component. The d.c. powered components of the system are primarily for operational safety. Power from the

high amperage-hour storage battery is supplied to the system's d.c. components whenever the d.c. switch is in the "ON" position. If the generator power fails, the flasher lamps located above the unit provide a warning to boat traffic and permit relocation of the light source system at night. The d.c. exhaust fan is essential to force-draft fresh air through the generator enclosure to remove any potentially explosive fuel fumes and to insure sufficient fresh air before starting the generator drive motor. Generator mountings and other hardware within the enclosure must be constructed to permit free air circulation so that fuel fumes cannot be trapped in dead air spaces. As a safety precaution, the generator starter can only be activated after the d.c. switch is turned on and the d.c. exhaust fan is in operation. The d.c. storage battery would also be used to supply power to an automatic timer or remote control switch.

The attraction lamp and additional safety features are powered directly by the a.c. generator. Whenever the generator is in operation, the generator "on-off" indicator lamp and the a.c. exhaust fan are operational. The generator indicator lamp provides a method for remotely checking whether the system is functioning properly. The a.c. exhaust fan prevents the buildup of heat and fumes within the generator enclosure when the generator is operational and helps to insure an adequate fresh air supply to the generator motor. The attraction lamp is activated only when the a.c. switch is in the "ON" position. We have utilized single attraction lamps with our prototype units; however, several floating satellite lamps attached by umbilical power cords could be operated from these units. All a.c. electrical components are grounded to the water to reduce shock hazard during operational handling—extreme caution should be used when the lamp system is operated on deck for checkout.

We selected a subsurface fish attraction lamp for our light source system to eliminate the air-water interface

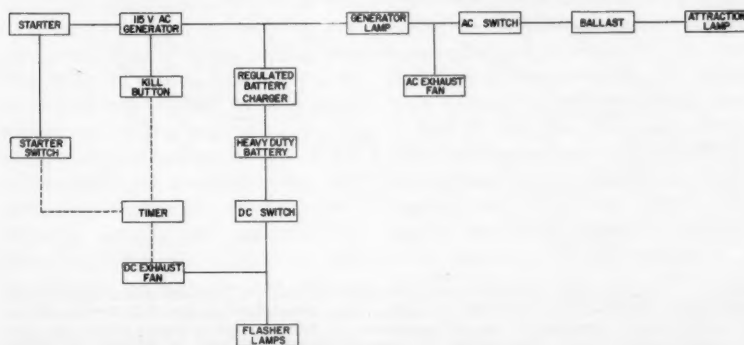


Figure 2.—Schematic diagram of the components for the self-contained light source system.

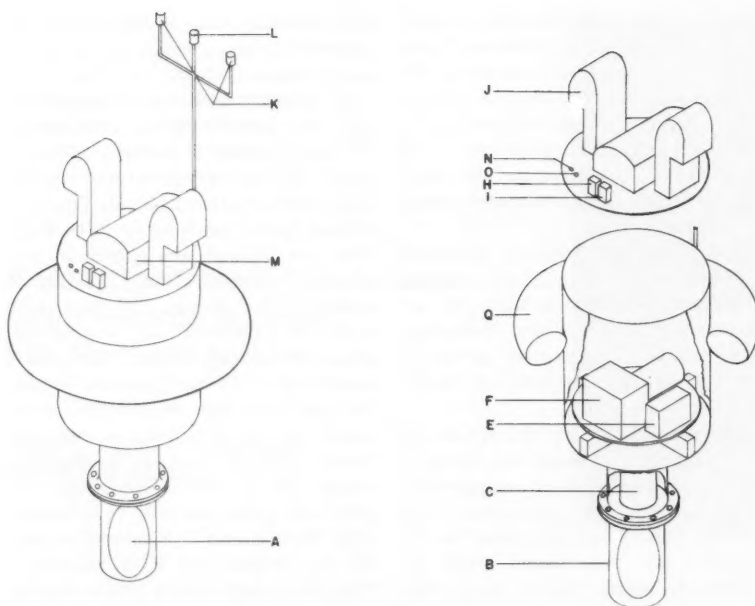


Figure 3.—A diagrammatic illustration of the prototype FLAB unit; (A) 1,000-watt mercury vapor lamp, (B) Plexiglas lamp shield, (C) Ballast for the mercury vapor lamp, (E) Heavy duty D.C. storage battery, (F) 2.5 KW gasoline powered 110 volt A.C. generator, (H) D.C. power switch, (I) A.C. power switch, (J) Generator enclosure air vent, (K) Flashing, D.C. safety lamps, (L) A.C. generator operation indicator lamp, (M) Gasoline tank, (N) Generator kill button, (O) Generator starter button, (Q) Flotation collar.

losses from reflection and refraction which reduce penetration of surface light into the water. This approach makes the subsurface lamp more efficient than a comparable surface lamp and is capable of creating a larger area of illumination with an increased underwater range of lamp visibility. A subsurface lamp also avoids the placement of a bright light source above the surface, which might create a hazard to navigation. Another advantage of using an underwater attraction lamp was the creation of a uniform 360-degree horizontal light field which provided the fish with an unobstructed view of the light source. Illumination efficiency was increased by using mercury vapor lamps which have their strongest light emission between 480 and 580 millimicrons, the range of wave lengths which have the greatest transmission in sea water.

To reduce the cost of our prototype underwater light system, we utilized a

ballast unit and lamp from a conventional street light. The lamp was mounted in a rubber, watertight, mogul base socket in direct contact

with the water. This underwater lamp socket is available from Hydro Products, Inc.<sup>1</sup> A clear, heavy walled, plexiglas, openend cylinder was used to shield the lamp from mechanical damage.

## PLATFORM DESIGN CONSIDERATIONS

The two prototype platform configurations of our light source system were designed and evaluated to test different operational requirements for specific fishing applications.

### Fish Light Attraction Buoy (FLAB)

The spar buoy configuration was designed for fixed station operation. Lamp systems with this configuration were intended to function as the basic unit either individually or as one of a string of sequentially operated lamps used to attract and lead fish to selected harvesting sites. Each FLAB unit can be modified to power several satellite attraction lamps thereby reducing the

<sup>1</sup>Use of trade names in this publication does not imply endorsement of commercial products by the National Marine Fisheries Service, NOAA.

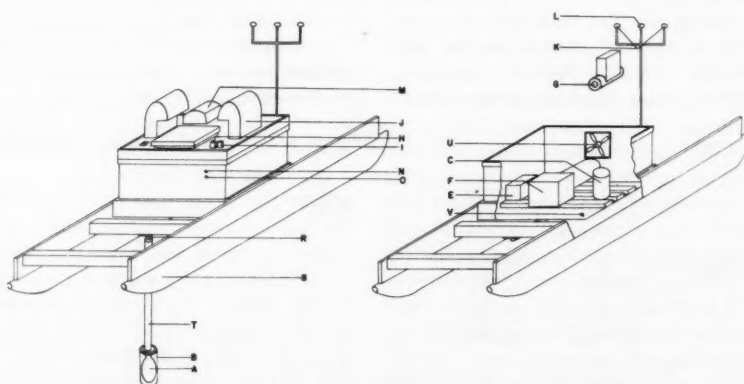


Figure 4.—A diagrammatic illustration of the prototype FLAC unit, (A) 1,000-watt mercury vapor lamp, (B) Plexiglas lamp shield, (C) Ballast for the mercury vapor lamp, (E) Heavy duty D.C. storage battery, (F) 2.5 KW gasoline powered 110 volt A.C. generator, (G) D.C. generator enclosure exhaust fan, (H) D.C. power switch, (I) A.C. power switch, (J) Generator enclosure air vent, (K) Flashing D.C. safety lamp, (L) A.C. generator operation indicator lamp, (M) Gasoline tank, (N) Generator kill button, (O) Generator starter button, (R) Universal joint, (S) Flotation pontoons, (T) Underwater lamp swing arm extension, (U) A.C. enclosure exhaust fan, (V) Generator enclosure drain plug.

number of power units required for sequentially operated lamp strings.

The primary consideration in the design of the FLAB unit was to achieve a buoy system with good stability since motion in the tilt or roll axis had to be minimized to prevent the underwater lamp from moving about quickly and creating a fright-escape reaction in the light attracted fish. The forces involved in providing buoy stability are illustrated in Figure 5. A floating body is in equilibrium when the weight and buoyancy forces act along the vertical axis of the body. The best stability is obtained when the center of gravity is below the center of buoyancy.

The modified spar buoy configuration utilized for our prototype FLAB unit provides a platform stable in the tilt or roll axis. It was designed to maintain two-thirds of the unit's volume below the surface and maintain the center of gravity below the center of buoyancy. Since the center of buoyancy shifts to a new position as the buoy tilts or heels, surface buoys have to be designed with a wide range of stability accompanied with maximum righting moments at high angles of tilt. We installed a flotation collar around the buoy to increase the displacement of the buoy as it tilts and thus increase its righting moment. When the buoy is tilted from vertical, this collar greatly increases displacement on the low side of the buoy and simultaneously raises the center of buoyancy, thereby increasing the righting moment and opposing the tilting forces. The flotation collar also contributes to a large horizontal cross section which, along with a high weight to size relationship, damps vertical motion caused by sea surge. In addition, the flotation collar acts as a protective bumper when the buoy is being serviced on station. Consequently, almost all motion of FLAB occurs in the vertical direction and this motion is well damped for normal sea operation by proper weight distribution and a relatively large cross sectional area.

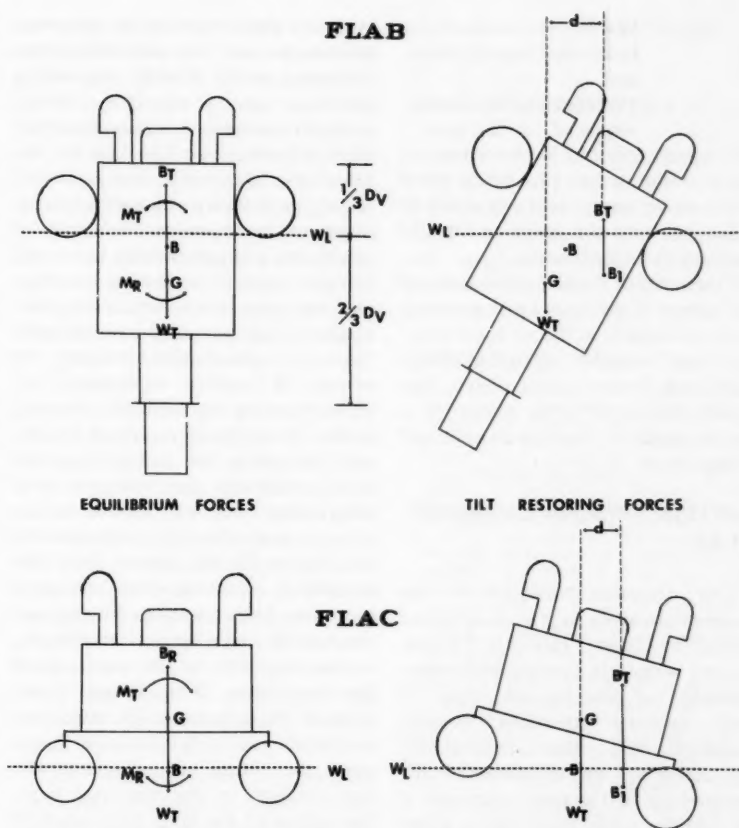


Figure 5.—A schematic diagram of the forces involved in stability for the FLAB and FLAC platforms. (B) Center of buoyancy, (BT) Total buoyancy, (G) Center of gravity, (WT) Total weight, (MT) Tilting moment, (MR) Righting moment, (WL) Water line, (Dv) Displacement volume, (d) moment arm length, (B1) New center of buoyancy resulting from tilt.

The stability of the FLAB unit is dependent upon a low center of gravity. Since the system generator is the heaviest single component, it was placed on the bottom of the main buoy body to keep its weight contribution as low as possible. A heavy flange pipe housing and the attraction lamp ballast were placed beneath the main displacement body to obtain the desired buoy water line and to provide a low center of gravity. We designed the FLAB platform with two-thirds of its volume submerged and one-third above the water line, without the flotation collar, utilizing the equation:

$$Dv_1 + Dv_2 + \dots + Dv_n - W_1 - W_2 - \dots - W_e = 1/3 Dv_t$$

or

$$Dv_t - W_b - W_e = 1/3 Dv_t$$

and

$$2/3 Dv_t = W_b + W_e$$

where

$Dv$  = Weight of water displaced by the volume of each buoy section,

$W$  = Weight of each buoy section,

$W_e$  = Weight of buoy equipment and fuel,

$W_b$  = Weight of buoy less equipment and fuel, and,

$Dv_t$  = Total weight of water displaced by the buoy.

The water-tight fuel tank located on top of our prototype FLAB was also a major weight component and would be redesigned into the lower sections of the buoy in future models.

Placement of the attraction lamp on the bottom of the buoy keeps the lamp below turbulence at the air water interface and provides an unobstructed light field; however, this design does require the buoy to be placed in a special cradle for on deck storage and transportation.

### **Fish Light Attraction Catamaran (FLAC)**

The catamaran configuration was designed primarily to provide a mobile attraction lamp platform. Lamp systems with this configuration were intended for leading fish clear of reefs, artificial structures, drilling platforms, and other obstructions. This design was also intended to facilitate passage of the lamp unit over a net corkline when used with a purse seine or other conventional fishing gear. The FLAC unit can also be modified to power several satellite attraction lamps and has potential for development into a remote controlled self-propelled fish leading unit.

Our primary consideration in the design of the FLAC unit was to develop a platform with high mobility and the ability to pass over net cork lines. Stability on station was also required to reduce motion transmitted to the underwater attraction lamp, thereby minimizing the fright-escape reactions in the light-attracted fish created by sudden movements of the lamp. The degree of stability obtained with a mobile surface platform is directly related to maintaining the unit in an upright attitude so that it will not capsize. By using the catamaran principle, a relatively small amount of surface area is in direct contact

with the water, making the buoy less reactive to water movements and thus achieving greater stability than with a platform, raft, or boat design. However, the stability of a catamaran platform will always be less than the stability of a spar buoy. The forces affecting the stability of a catamaran are illustrated in Figure 5. The center of gravity for a catamaran may be located relatively high above the water surface and above the center of buoyancy. Extension of the pontoons some distance from a vertical line through the center of gravity counteracts tilt forces keeping the platform relatively stable. Most motion occurs in a vertical direction as the buoyant platform moves with the sea, although some tilting does occur as it rides the surface of a sea swell. Since it was impossible to remove all tilt motion from the catamaran platform, the attraction lamp was further stabilized by mounting it at the end of an arm attached by a universal joint to the underside of the catamaran. This design allows little of the catamaran tilt motion to be transferred to the attraction lamp, since the tilting occurs around the free rotation of the universal joint. Movement of the lamp arm, when in the vertical position, is damped by weight and water resistance at its distal end. The universal joint also permits the attraction lamp to be raised horizontally between the pontoons and stowed under the catamaran body when the FLAC unit is being towed at sea, passed over net cork lines or transported by trailer.

### **SYSTEMS EVALUATION AND CONCLUSIONS**

Prototype units of both the spar buoy and catamaran configuration of the light source system were constructed and field tested at sea to evaluate design and operational concepts.

The modified spar buoy configuration (FLAB) was designed primarily for fixed station operation. Field evaluations with FLAB anchored on station

indicated that in the tilt or roll axis the prototype unit was acceptably stable. Vertical motion in the buoy was a function of sea swell height, although the response magnitude and rate were noticeably dampened by the flotation collar. In a strong current, FLAB would heel over slightly (i.e.,  $<10^\circ$  -  $15^\circ$  in a 2-knot current) as the lower section moved with the direction of the water flow (Figure 6). During these tests, the anchor line was attached above the buoy's center of gravity. A more vertical orientation could have been maintained under these high current conditions if more attention had been given to the methods and position of anchor line attachment. A bridle arrangement could be used effectively in maintaining a vertical buoy position when deployed in swift currents. On several occasions, FLAB was released from anchor and allowed to drift freely at night to facilitate purse seine capture of fish that had accumulated around the attraction lamp. Some difficulty was encountered in removing FLAB from the purse seine since it was not possible to either tilt the buoy or sink the net floats sufficiently to float the buoy over the cork line. Consequently, after each set FLAB had to be brought alongside the seiner and lifted out of the net with the ship's boom. Relatively calm seas (i.e.,  $<3$ -foot swell) were required for handling FLAB since it had to be carried on deck in a special cradle and deployed and retrieved over the side with the vessel boom.

Design changes recommended for the prototype FLAB unit involve improving the number and placement of pad eyes on the buoy to facilitate handling and anchoring. The control switches, ventilation fans and ducts, and the generator motor exhaust port should be moved from the buoy enclosure access lid to the upper outside section of the buoy. The prototype FLAB can be constructed from surplus material and locally available off-the-shelf components. A production model based on this



Figure 6.—The prototype FLAB unit anchored on station in a current greater than two knots.

system however, should have the buoy body specifically designed and components carefully selected to reduce the size and weight of the unit. A properly designed spar buoy would permit the lamp system to be further optimized for sea keeping ability and specific fishing applications.

Sea trial evaluations of the mobile platform catamaran configuration (FLAC) indicated this unit, with the attraction lamp stowed horizontally between the pontoons, could be towed at speeds up to 10 knots in relatively choppy seas. When FLAC was anchored on station or allowed to drift free with the lamp arm in the vertical fishing position, the attraction lamp was acceptably stable. During the static position test, the catamaran body rocked around the lamp arm universal joint, stepping over the surface chop and riding up and down the sea swell. Little of this motion was transmitted to the lamp. When FLAC was being towed to lead fish accumulated around its attraction lamp, the lamp arm swung back and up slightly as the towing speed was increased. This presented no problem since towing speed had to be kept relatively low to prevent the rate of lamp movement from exceeding the swimming speed of the fish. Experiments on the use of a moving lamp to lead coastal pelagic school fish for capture with a purse

seine are reported by Wickham (in press). No difficulty was experienced in bringing the FLAC unit across a corkline if the lamp arm was raised to the horizontal position. Handling the FLAC unit created few problems since it could be towed to the fishing grounds behind the fishing vessel.

Design improvements suggested from our field trials with the prototype FLAC unit involve moving control switches, ventilation fans and ducts, and the generator motor exhaust port from the enclosure access lid and mounting them on the side walls of the enclosure. The generator enclosure should also be made smaller to reduce dead air space. The attraction lamp arm-universal joint attachment point should be located directly at the center of platform rotation and not at one end of the unit as shown on the prototype. A mechanical winch should also be added to facilitate raising the lamp arm to a horizontal position. The platform pontoons should be replaced with heavy duty units to resist the rough treatment associated with fishing operations.

Our field evaluation of the self-contained subsurface light source system indicates the catamaran configuration offers the greatest potential and flexibility for use in most anticipated fishing applications. The FLAC platform is simpler to construct and units based on this design could be easily built by fishermen, using materials and system components readily available in most locations. The FLAB configuration appears to be more suitable for specific fishing applications such as the establishment

of lamp strings which will not be moved frequently.

## ACKNOWLEDGMENTS

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## LITERATURE CITED

- Brandt, Andres, von. 1972. Fish catching methods of the world. Fishing News (Books) Ltd., London, 240 p.
- Bullis, H. R., Jr., and J. S. Carpenter. 1968. Latent fishery resources of the Central West Atlantic Region, p. 61-64. *In* The Future of the Fishing Industry of the United States, Vol. IV. Univ. of Wash., Publications in Fisheries (New Series).
- \_\_\_\_\_, and John R. Thompson. 1967. Progress in exploratory fishing and gear research in region 2, fiscal year 1966. U.S. Fish Wildl. Serv., Circ. 265, 14 p.
- \_\_\_\_\_, and \_\_\_\_\_. 1970. Bureau of Commercial Fisheries exploratory fishing and gear research base, Pascagoula, Mississippi, July 1, 1967 to June 30, 1969. U.S. Fish Wildl. Serv., Circ. 351, 29 p.
- Duncan, T., Jr. 1952. Fishing lure for use in connection with haul seine systems. U.S. Patent No. 2,582,015.
- Klima, Edward F. 1970. Development of an advanced high seas fishery and processing system. Mar. Tech. Soc. J. 4(5):80-87.
- \_\_\_\_\_. 1971. The automated fishing platform, p. 498-501. *In* H. Kristjonnson (Ed.), Modern Fishing Gear of the World, Vol. 3. Fish finding, purse seining, and aimed trawling. Fishing News (Books) Ltd., London.
- Wickham, Donald A. 1970. Collecting coastal pelagic fishes with artificial light and a 5-meter lift net. Commer. Fish. Rev. 32(12): 52-57.
- \_\_\_\_\_. 1971a. Harvesting coastal pelagic fishes with artificial light and purse seine. Commer. Fish. Rev. 33(1): 30-38.
- \_\_\_\_\_. 1971b. Nightlighting — a harvesting strategy for underutilized coastal pelagic school fishes. Proc. Gulf Caribb. Fish. Inst. 23rd Annu. Sess. Curacao, N.A., Nov. 1970: 84-90.
- \_\_\_\_\_. In press. Attracting and controlling coastal pelagic fish with nightlights. Trans. Am. Fish. Soc.

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*Increased U.S. fish consumption and a static domestic catch have led to heavy dependence on foreign imports.*

## Factors in the Fish Picture of Concern To Industry and Consumers

MORTON M. MILLER

### INTRODUCTION

Considerable attention was focused on fishery products during the spring 1973 "boycott" of meats carried out by many U.S. consumers. Fish and shellfish sales were brisk and consumers in at least some areas formed long queues to purchase fish. No doubt these lines included some very occasional fish eaters—perhaps some new ones—but it is likely that a large number were already regular consumers of fishery products.

The fact is fish and shellfish have a traditionally important place in the U.S. food and nutrition picture. Thus, the "boycott" phenomenon likely will be recorded as a relatively minor incident in the history of fish consumption in the United States. Nevertheless, the incident did bring to the surface nagging questions regarding the outlook for fishery supplies and, of course, prices. The concern was whether the supply potential was adequate to meet the requirements of any sudden surge in demand for fish in the United States. Probably it is not, in the short run,

although the longer run picture could be brightened by way of improved stock management, development of underutilized species, and aquaculture. Because the short run commands our immediate attention, it is useful to review aspects of the position of fish in the present food and nutrition picture.

### U.S. FISH CONSUMPTION

The United States is one of the largest users of fishery products in the world. In 1972, U.S. consumers disposed of the equivalent of about 6.8

Table 1.—Per capita fish consumption in several selected countries in 1972.

Nation	Pounds edible weight
U.S.	12.2
Germany	8.9
France	17.7
Italy	13.7
Netherlands	12.9
Switzerland	9.7
Argentina	4.8
Australia	12.9
New Zealand	14.5

billion pounds of whole fish, in various product forms. Additionally, about 7 billion pounds were used in the form of feeds, pet foods, and other industrial products. Only Japan, the People's Republic of China, and the USSR consume more fish than the United States.

Consumption of fishery products in the United States, on a per capita basis, is relatively small compared with meat and poultry. A record 12.2 pounds per capita of fish consumed in the United States in 1972 compares with about 189 pounds for meat (beef, veal, pork, lamb) and about 52 pounds for poultry. Nevertheless, fish have an important role as a "change of pace" item in the general U.S. diet and, in some cases, as an essential part of special diets. It is relevant that lifting of the U.S. Catholic religious ban on eating

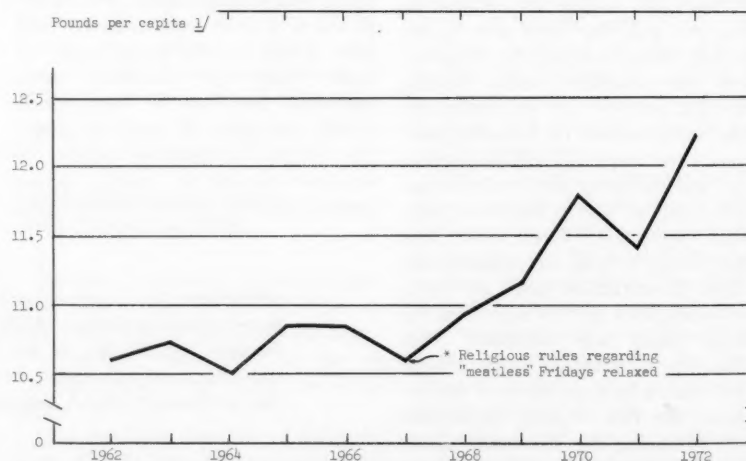


Figure 1.—Per capita consumption of fishery products in the U.S. (pounds per capita, edible weight), from *Fisheries of the United States*, 1972.

Morton M. Miller is Chief, NMFS Market Research and Services Division, NOAA, Washington, DC 20235.

meat on Fridays, which occurred in 1967, had no discernible lasting effect on fish consumption. In fact, per capita consumption climbed steadily thereafter (Figure 1).

Per capita consumption of fish in the United States also is consistent with levels consumed in other countries where meat production is high, and with other industrialized countries where large populations are concentrated at a distance from coastal areas (Table 1).

### DEMAND INCREASING FOR FISHERY PRODUCTS

Increasing consumption and rising prices are the two major factors that point to increasing demand for fishery products in the United States. Since 1960 the total quantity of fish and shellfish consumed in the United States has increased 67 percent. Representative retail prices during the same period increased about 80 percent. For perspective, it is useful to note that the U.S. population has increased only 16 percent since 1960, and the average gain in prices for all foods has been about 40 percent. The data in Table 2 summarize these comparative changes in the United States.

Table 2.—Per capita U.S. fish consumption and consumer price indexes since 1960.

	1960	1972	Percent change
Total fishery products used in U.S., (million pounds, live weight)	8,223	13,753	+67.3
Per capita consumption edible weight (pounds)	10.3	12.2	+18.4
Consumer price indexes (1967 = 100)			
Fish	85.0	152.8	+79.8
Meat	87.2	129.2	+48.2
All food	88.0	123.7	+40.6
All items	88.7	129.8	+46.3

The rise in demand for fishery products is associated with increasing incomes for, as their incomes increase, consumers seek to improve their diets. In the United States, per capita buying power ("real" disposable income) has increased over 40 percent since 1959

and the gains in per capita consumption of major protein foods shown in Table 3 were made during the same period.

Table 3.—Per capita consumption of major protein foods (in pounds) in the U.S. since 1959.

	1957-59 Average	1972	Percent change
	Pounds		
Meat	156.6	188.8	+20.6
Fish	10.5	12.2	+18.4
Poultry	33.5	51.8	+54.6
Cheeses	7.9	13.1	+65.8

### DIET IMPROVEMENT IN MANY PARTS OF THE WORLD

The trend toward better eating has not been confined to the United States. Worldwide, incomes and standards of living have been rising, giving impetus to improve diets. Probably the best example is Japan, where "real" per capita income has increased more than 2.5 times since 1960. The Japanese have responded by decreasing their use of cereals, for example, and increasing their intake of such foods as meat, eggs, fish, and milk (Table 4). Similarly, diets have improved in other nations where there has been notable economic growth—Italy and Spain, to cite examples.

Worldwide, signs of diet improvement are seen in growing consumption of animal proteins with fishery products prominent in the growth picture (Figure 2). In Japan, for example, fish and shellfish provide over 50 percent of the animal protein in the average diet; in the Philippines, the figure is 48 percent. Among European countries, fish provide as much as 17-18 percent of the animal protein consumed, and the average for the continent is

Table 4.—Changes in Japanese consumption of staple foods since 1960 (in grams per person per day).

Food items	1960-62	1970
	----- Grams -----	
Cereals	410	352
Starches and other staples	185	161
Fruit	83	142
Meat	22	48
Eggs	24	45
Fish	80	88
Milk	69	137

probably around 10 percent. In the U.S. and in Canada, about 5 percent of the animal protein consumed derives from fish, while in South America the percentages run much higher—26 percent in Peru, for example.

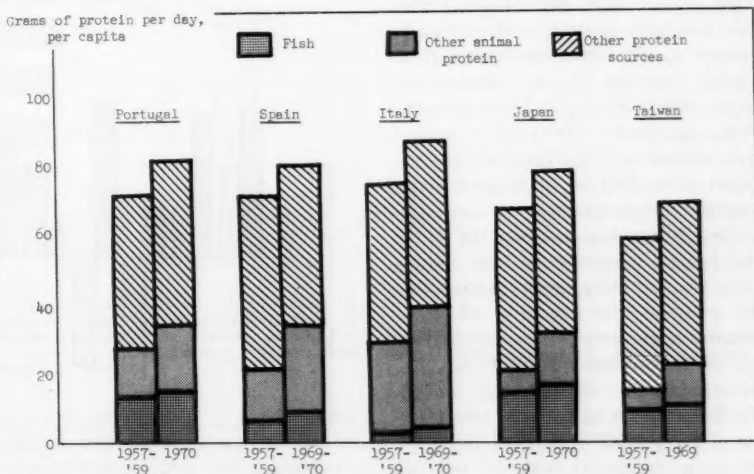


Figure 2.—Some examples of countries with rapidly developing economies where protein consumption increased substantially during the 1960's.

## INCREASED INVESTMENT IN FISHERIES

The swelling demand for fish throughout the world has generated increased investment and effort in fishery enterprises in many nations, for international trade and feeding home populations, as well. Between 1965 and 1970 the number of powered vessels in the Japanese marine fleets increased 22 percent, from 217,156 to 265,652. At the same time, the number of non-powered vessels decreased by more than a third. Significantly, the increases in Japanese fishing fleets include a substantial gain in the number of large vessels capable of operating in distant waters (Table 5).

Table 5.—Increases in Japanese fishing vessels, 200 tons and over.

	Number of vessels		Change	
	1965	1970	Number	Percent
200-499 GT	824	1,251	427	51.8
500-999 GT	97	117	20	20.6
1000 GT and over	156	208	52	33.3

In the United States there has also been some expansion of fishing fleets. The number of powered vessels increased 13 percent during 1965-1970 from 76,139 to 86,400. Much of the gain has been in small craft, under 5 gross tons, and there has been only a modest increase in the number of larger vessels. Over the 5-year period, about 98 vessels, 200 tons or more, were added to U.S. fleets, whereas in Japan about 500 of the larger vessels were put into operation.

The differential between the U.S. and Japan, in number of large vessel additions to fishing fleets, underscores the essential characteristics of U.S. fisheries operations, which are carried out in fairly close proximity to our national shores, by relatively small-sized vessels. In U.S. fleets, about 17 out of every 1,000 vessels are 200 tons or more, compared with 60 out of every 1,000 Japanese fishing craft in this size class. This is consistent with

the fact that 75 percent of the U.S. catch is taken in waters within 12 miles from U.S. shores. An additional 13 percent comes from "offshore" fisheries, and only 11 percent from distant waters, off foreign coasts. In contrast, 40 percent of the Japanese sea fisheries catch is from "distant" waters.

## FISHERIES GROWTH IS DECLINING

Increased fishing effort has resulted in heavier catches, by various countries. The world catch increased 30.5 percent from 1965 to 1971. Large gains were made by the leading three fishing nations: Japan (43%); USSR (44%); and Peru (39%). The U.S. catch during the period increased only 2.6 percent. (The U.S. ranks 6th in the world in total fish catch, down from 5th place in 1965.)

The trend in world catch, however, shows a declining growth rate. For the period 1960-1966 the annual compound percentage growth was 6.1 percent. Over the ensuing 5 years—1966-1971—growth averaged 4.1 percent. The best description of the U.S. catch since 1960 would be that it has been relatively stable. Over

1960-1966, there was a slight decline of about 2 percent per year, compound rate, which was offset by a yearly gain of 2.7 percent from 1965 to 1971. There was, however, slippage in 1972, when there was a 5 percent drop in landings from a year earlier.

The disparity between changes in the U.S. and world catch of fish (Figure 3) has caused the U.S. contribution to world catch to slip from 5.6 percent in 1960 to 3.2 percent in 1971, as shown in Table 6. The more pronounced

Table 6.—U.S. contribution to world fisheries catch since 1960 (million pounds).

	1960	1971
World catch	88,000	153,000
U.S. catch	4,942	4,969
U.S. percent of world catch	5.6	3.2

changes in the world fish catch relate to species processed for industrial or other nonfood uses (particularly animal feeds). The gains in catches for human food have been modest worldwide and this part of the U.S. catch has been declining.

In 1971, the world catch for human food comprised 60 percent of the total, compared with 79 percent in 1960. The U.S. catch in 1960 was

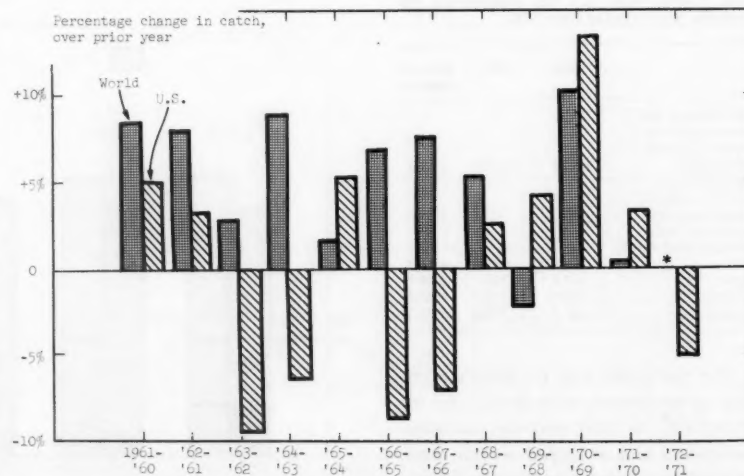


Figure 3.—The U.S. has not matched growth in world catch (world catch data for 1972 not available). Source, United Nations Food and Agriculture Organization, *Yearbook of Fishery Statistics, "Catch and Landings,"* 1971, Vol. 32.

divided about evenly between "human food" and "other" purposes. The latest recorded U.S. catch (1972) shows a slight edge for quantity landed for other than human food (Tables 7 and 8).

**Table 7.—Compound annual growth rate (percent) in U.S. and world fish catch since 1960.**

	1960-66	1966-71	1971-72
World catch for:			
Human food	+ 3.3%	+ 1.8%	N/A
Other purposes	+ 13.8%	+ 8.3%	N/A
U.S. catch for:			
Human food	+ 0.5%	- 1.5%	- 3.7%
Other purposes	- 5.0%	+ 7.4%	- 6.6%

**Table 8.—Actual change in composition of U.S. and world fish catch since 1960 (million pounds).**

	1960	1971	Percent change
World catch for:			
Human food	69,080	91,800	+ 33
Other purposes	18,920	61,200	+ 233
U.S. catch for:			
Human food	2,498	2,400	- 4
Other purposes	2,444	2,569	+ 5

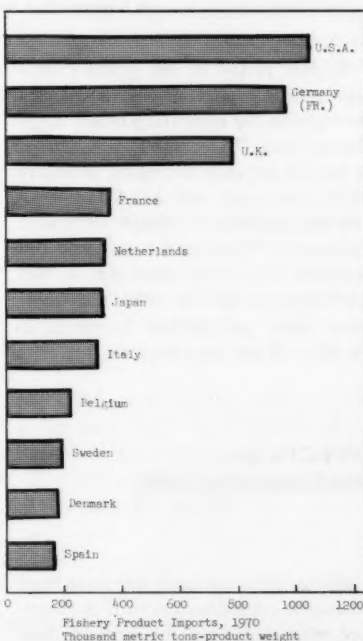
## CONCENTRATION IN U.S. FISH CONSUMPTION

The U.S. appetite for fish and shellfish extends over a multitude of species, but there is heavy concentration in a few products. Canned tuna and shrimp, for example, account for 35 percent of fishery food products consumed in the U.S. (24 percent tuna, 11 percent shrimp). Add in canned salmon, and sticks and portions, (the latter manufactured from frozen blocks of fillets which are mostly cod) and 61 percent of U.S. consumption of fishery products is accounted for.

Consumption patterns follow the mix of U.S. landings wherein the traditional leading species are tuna, salmon, and shrimp. The three species account for nearly half the U.S. catch of fish sold for human food. The remainder of the catch includes a large variety of fish and shellfish, among which the leaders (in terms of quantity) generally are crabs, clams, flounder, and oysters.

## IMPORTANCE OF IMPORTS

There has been little change in the quantity of U.S. landings of fish over the past several years, although demand and consumption have increased steadily. Imports have made up the discrepancy, and the United States is the world's heaviest importer of fishery products (Figure 4). Between 1960 and 1972 the quantity of "edible" fishery products in the U.S. has more than doubled, and their value has quadrupled. Over the same period, the U.S. "edible" catch has decreased slightly, while the value of the catch has about



**Figure 4.—The U.S. is the world's leading importer of fishery products, including those for human food and other purposes. Source, FAO Yearbook of Fishery Statistics, "Fishery Commodities," 1970.**

doubled. As a result of these events, imports now supply about 66 percent of our "edible" fish and shellfish requirements, compared with 41 percent in 1960.

Imports of raw fish are highly important in domestic production of leading fishery products consumed in the United States. For many years imports have supplied well over half the raw tuna that goes into the U.S. canned tuna pack. During the 1960's the ratio of imported raw tuna to domestic-caught tuna in the pack has been about 1.2 to 1.0. There was, however, a surge of imports in 1972 and the ratio climbed 1.68 to 1.0. Thus, the equivalent of three out of every five cans of tuna on supermarket shelves were processed from imported raw fish. U.S. tuna landings over the last 5 years (1968-1972) have averaged considerably higher than the prior 5-year average (1963-1967), but the gains have not kept pace with increased requirements (Table 9).

**Table 9.—U.S. tuna landings and tuna imports, 1968-72 (five-year averages), in millions of pounds.**

5-year average	U.S. Landings	U.S. Imports
1963-67	368	382
1968-72	459	514
Percent increases	+ 24.7	+ 34.6

A somewhat similar picture exists for shrimp. Regularly, over half the shrimp consumed in the United States represents imports. However, domestic landings have been increasing significantly, and growth has even outpaced the growth in imports. Thus, the ratio of imports to domestic catch has moved in a direction favoring domestic. In 1971, for example, domestic landings made up 54 percent of the U.S. shrimp supplies, but the proportion dropped to 48 percent in 1972. The 5-year averages compare changes in domestic shrimp landings with imports (Table 10).

**Table 10.—Comparative 5-year average changes in U.S. shrimp landings and imports, in millions of pounds.**

	Domestic landings	Imports
1963-67	154	182
1968-72	215	227
Percent change	+ 39.6	+ 24.7

Across the board there is a growing dependency on imports among fishery products consumed in the United States. In this connection, it should be noted that 95 percent or more of the raw fish requirements for fish sticks and portions production comes from imports. The volume of U.S. landings of the species that go into sticks and portions—namely, cod, flounder, haddock, ocean perch, and pollock—do not meet the production requirements for sticks and portions. Much of the U.S. catch of these species is channeled into the higher-priced fresh and frozen fillet markets. Moreover, the U.S. landings of these species have dropped precipitously over the years—a statement that can be made for a large number of U.S.-caught species (Table 11).

Table 11.—U.S. landings of some marine fish in millions of pounds.

Species	Landings			Record Landings	
	1965	1970	1972	Qty.	Year
Crabs	335.4	277.2	281.1	372.4	1986
Flounder	180.1	168.5	168.8	180.1	1965
Cod	46.2	56.2	56.6	294.4	1880
Ocean perch	83.6	55.3	58.8	258.3	1951
Oysters	54.7	53.6	52.5	152.0	1908
Jack mackerel	66.9	47.7	52.8	146.5	1952
Whiting	82.6	44.5	26.7	133.0	1957
Haddock	133.9	26.9	11.7	293.8	1929
Pacific halibut	39.7	34.5	26.8	66.7	1915

## INCREASING FISH PRICES

The inevitable outcome of growing demand for fishery products in the U.S. in face of tightening supplies has been higher prices (Figure 5). According to price indexes computed by the Bureau of Labor Statistics, consumers paid \$1.75 for purchases of frozen fish in retail markets that cost \$1.00 in 1967. Similarly, \$1.46 was needed this past March to buy shrimp that cost \$1.00 back in 1967. The pinch, of course, has not been felt only by consumers.

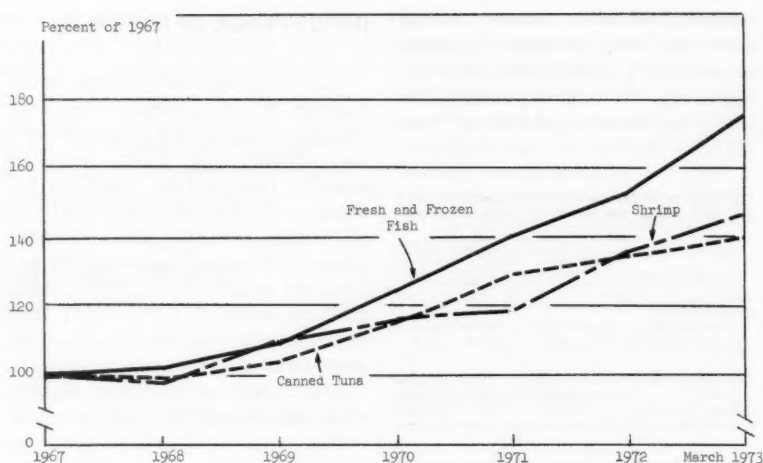


Figure 5.—Fish and shellfish prices have been increasing but rate of change has not been uniform among products (Bureau of Labor Statistics, BLS, Index of Fish and Shellfish retail prices, 1967-100).

Higher prices in the grocery markets reflect higher prices (and costs) throughout the marketing chain. Light chunk tuna, 7½ oz/48's, was quoted at \$20.70 per case, fob plant, in March 1973, compared with \$13.50 in 1967. The tuna canners in March 1973 were paying \$477 per ton for domestic raw yellowfin tuna they were able to buy for \$281 per ton in 1967, and there have been comparable increases in the price of raw tuna imports.

Table 12.—Increase in landings and dockside prices of tuna and flounder.

	1965	1972	Percent change
<b>Tuna</b>			
Landings (million pounds)	318.9	377.6	+ 18.5
Average dockside price (cents per pound)	13.1	23.8	+ 81.7
<b>Flounder</b>			
Landings (million pounds)	133.7	168.8	+ 26.2
Average dockside price (cents per pound)	10.9	14.2	+ 30.3

## EFFECTS ON FISHERMAN INCOME

Higher prices at dockside have been somewhat compensatory to U.S. fishermen who have seen the sizes of their catch shrink or remain stable (Tables 12 and 13). Also, where domestic catches have increased, prices have gone up even faster. Tuna is a good example of the latter case.

Overall, there has been a strong upward trend in the value of the U.S. catch which has been the result of relatively stable landings and uninterrupted gains in price. Between 1965

Table 13.—Pacific halibut landings and revenues.

	1965	1972	Percent change
<b>Halibut landings</b>			
(million pounds)	39.7	26.8	- 32.5
Value (million dollars)	9.0	13.2	+ 46.6
Average price (cents per pound)	22.7	49.2	+ 116.7

and 1972 the value of the U.S. catch rose 58 percent (Table 14). While total revenues from fishing have been increasing sharply, there has been only a modest increase in the number of fishermen, and almost no change in the number of persons employed in processing and wholesaling (Table 15).

Table 14.—Increase in value of U.S. catch between 1965 and 1972.

	1965	1972	Percent change
Value of catch (million dollars)			
For food	409	658	+ 60.9
Other purposes	37	46	+ 24.3
Value per pound (cents per pound)			
For food	15.8	28.5	+ 80.4
Other purposes	1.7	1.9	+ 11.8

Table 15.—Persons employed in fishing, and processing and wholesaling in 1965 and 1970.

	1965	1970	Percent change
U.S. fishermen employed	128,565	140,300	+ 9.1
Processing and wholesaling	86,865	86,813	—

Table 16.—Commercial fish catch and value by geographical region in 1965 and 1972.

	Catch (million pounds)		Value (million dollars)		Percent change	
	1965	1972	1965	1972	Catch	Value
New England,						
Mid-Atlantic	1,058	728	99.5	136.2	- 31	+ 37
Chesapeake	592	731	40.2	44.3	+ 23	+ 10
South Atlantic	357	284	26.8	44.3	- 20	+ 65
Gulf of Mexico	1,463	1,585	113.5	223.4	+ 8	+ 97
Alaska	491	390	70.2	80.7	- 21	+ 15
Washington,						
Oregon	196	213	27.3	62.5	+ 9	+ 129
California	458	640	50.7	91.9	+ 40	+ 81
Great Lakes,						
Miss.	141	124	13.7	15.1	- 12	+ 10
Hawaii	20	15	3.6	5.1	- 25	+ 42

## REGIONAL VARIANCE

The fortunes of commercial fishery enterprises have varied considerably with geographical regions (Table 16). The data indicate that, since 1965, Gulf of Mexico fisheries—supported mainly by shrimp—have been prosperous in terms of gross earning. Pounds landed of all fish at Gulf ports during 1965-1972 increased a modest 8.3 percent, but the value of these landings was up 96.8 percent. In New England, where landings dropped more than 30 percent over 1965-1972, the value of the catch rose 37 percent. Among the less fortunate areas were Alaska and the Chesapeake Bay region. Compensatory price increases in Alaska were modest by comparison with other regions, and in the Chesapeake, heavier landings were accompanied by a decrease in average value per pound landed.

## SUMMARY

The foregoing has pointed out some of the highlight features that shape the role of fish in the U.S. food and nutrition picture. What comes through

clearly is a less-than-favorable supply picture. Demand is increasing for fishery products in the United States, but there have been no parallel increases in the domestic catch. Dependence on imports is increasing, and even here, the picture for the United States is not so bright owing to increasing demand for fishery products in other countries, and a slowdown in growth of the world catch.

Fishery products are a small, but nonetheless, important part of the U.S. diet. Consumers have expressed their preferences in their willingness to pay increasingly higher prices for fishery products.

It would be idle speculation to attempt an estimate of how high fishery prices can go. It is probably accurate to state, however, that consumers and the fisheries industry together would welcome an increase in supplies which would dampen the sharp price upturn. How to increase supplies is a complex, but not hopeless, problem and one that the combined efforts of technology and business can cope with through development of underutilized fisheries, better management of developed fisheries, improved utilization of developed species, and aquaculture.

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*Man-made changes in south Florida threaten estuarine environments—home for a multimillion dollar fish industry.*

## Alterations of Estuaries of South Florida: A Threat to Its Fish Resources

WILLIAM N. LINDALL, JR.

### ABSTRACT

*Based on unpublished data from 1966-1970, about 85 percent of the commercial fish and shellfish caught in south Florida consists of estuarine-dependent species. The annual harvest of these species averaged more than 36 million pounds worth in excess of \$10 million (ex-vessel value). Data on the region's sport fishery are lacking, but it is estimated that the majority of the species taken by anglers are estuarine-dependent and responsible for about \$575 million of the State's annual tourist industry. Man's alterations of the estuaries are threatening these fish resources. Some of the major alterations, reduction of freshwater runoff, domestic and industrial pollution, pesticide contamination, thermal addition, and dredging and filling, are discussed.*

### INTRODUCTION

The mangrove dominated bays and rivers of south Florida provide food and protective habitat for hundreds of marine species of fish and shellfish which occupy these areas as juveniles and are thus dependent on the brackish water zone for survival. Many of these species are harvested by commercial and sport fishermen and are worth several million dollars annually to Florida's economy. The burgeoning human population of south Florida with its attendant demands for housing, industrial, and agricultural development, however, is upsetting the ecological balance of the estuarine ecosystem, thereby threatening the estuarine-dependent species.

The purpose of this report is to define the importance of south Florida's estuarine ecosystem to the production

of marine fish and shellfish, and to discuss some of the major threats to these resources.

### COMMERCIAL FISHERY

Unpublished catch data were collated to show the location, magnitude, and value of south Florida's commercial fishery. For the purpose of depicting locations of the commercial fishing grounds, statistical subdivisions of the grounds with code numbers and names used by the National Marine Fisheries Service are shown in Figure 1. Catches within each statistical area for the latest five-year period of record (1966-1970) were analyzed to determine the percentage of the catch composed of estuarine-dependent species. This was accomplished by reviewing the literature on the life history of each species

**William N. Lindall is a fishery biologist at the National Marine Fisheries Service, Gulf Coastal Fisheries Center, Panama City Laboratory, Panama City, FL 32401.**

and listing the major species known to utilize estuarine waters during some phase of their life cycle, usually the early phase. Average annual harvests of these species were determined, subdivided into the categories "finfish" and "shellfish," and arranged in decreasing order by weight (Table 1). Annual harvest averaged more than 36.3 million pounds worth over \$10 million and represented about 85 percent of the catch and value of all marine fishery resources taken commercially in south Florida during the five-year period. Striped mullet (*Mugil cephalus*) and pink shrimp (*Penaeus duorarum*) were the two major crops, representing 70 percent of the weight and 79 percent of the value.

### SPORT FISHERY

The results of Higman (1967, 1969), who reported on the quantity and species composition of fish caught in the Flamingo Area in 1959-1966 and 1969, are the only studies on sport fishing available for south Florida. Higman stated that the top three species preferred by fishermen in the area were spotted seatrout (*Cynoscion nebulosus*), gray snapper (*Lutjanus griseus*), and red drum (*Sciaenops ocellata*). All three are estuarine-dependent.

Reliable estimates of the value of the sport fishery are not available. A rough estimate can be obtained, however. McQuigg (1971), estimating that 31 percent of Florida's visitors come for the fishing, reported that sport fishing in the state was responsible for about \$1.7 billion of the \$5.5 billion tourist industry. Based on 33.8 percent of the state's "user occasion"—one instance of participation in salt-water sport fishing by one person—occurring in south Florida (Florida

Department of Natural Resources, 1971), I calculated that the south Florida sport fishery is responsible for about \$575 million (33.8 percent of \$1.7 billion) of the State's tourist industry. Therefore, sport fishing plays a significant role in south Florida's economy.

## THREATS TO THE FISHERIES

Man-made changes in the natural environment of south Florida are creating myriad problems for those of us charged with the responsibility of protecting against over-exploitation and despoilment of living marine resources. Unquestionably, the majority of marine species important to man are inextricably linked to the estuarine environment, and because of the physiographic and hydrologic makeup of south Florida, the estuarine ecosystem may be adversely affected by changes many miles inland as well as by changes in the estuary proper. Some of the major changes and, therefore, threats to marine fishery production are discussed below.

### Reduction of Freshwater Runoff

Freshwater runoff is one of the most important factors affecting south Florida's aquatic ecosystem. For example, Everglades National Park, which contains the majority of south Florida's estuarine area, is entirely dependent on freshwater flow from north of its boundaries (Tabb and Idyll, 1964). However, man has increasingly altered natural drainage patterns in the fertile wetlands and thereby reduced freshwater runoff to the estuaries. The following is a brief history of these alterations taken from Tabb (1963, 1966), Idyll (1965, 1969), and Heald (1970).

Originally the watershed of south Florida's estuaries extended as far north as Ocala in central Florida and covered about 9,000 square miles.

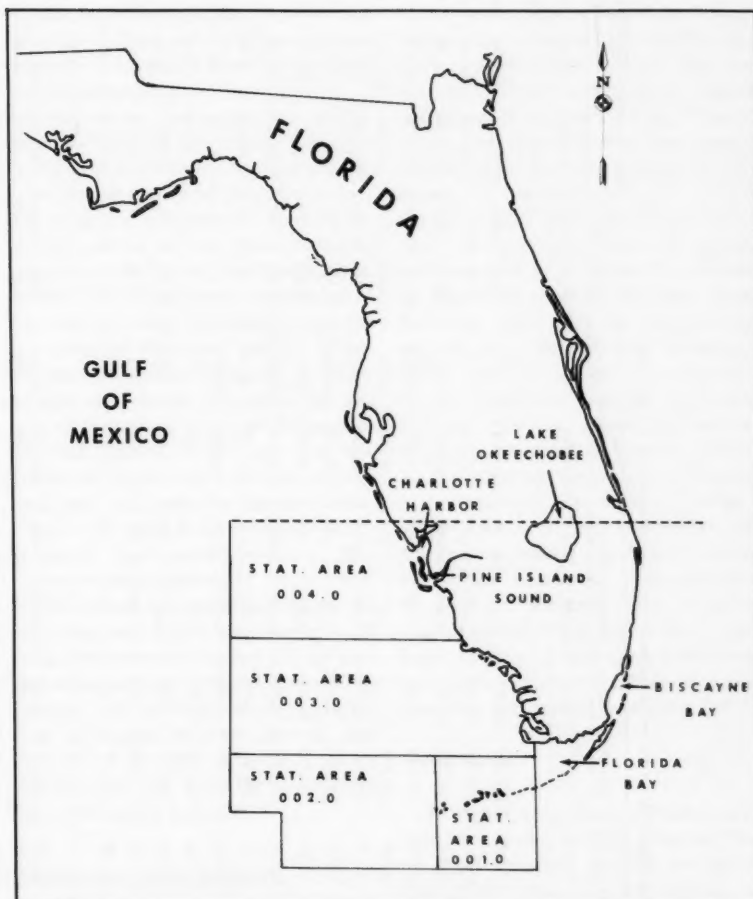


Figure 1.—Statistical subdivisions of south Florida fishing grounds.

Canal and levee construction for land reclamation and flood control purposes began in the 1880's and has been almost continuous since that time. The most drastic changes in freshwater flow came in the 1920's with construction of numerous canals draining into the Atlantic Ocean. In 1930 a dike was begun around Lake Okeechobee to prevent a recurrence of overflow from hurricanes such as the one in 1928 which killed an estimated 1,500-2,000 people. Additions are still being made.

With the creation of the Central and South Florida Flood Control District (FCD) in 1949, more canals

were dug, and extensive levees and water control structures were built. The Kissimmee River, the largest tributary to Lake Okeechobee, was channeled and straightened, and channels from the Lake were enlarged. This allowed millions of gallons of fresh water to drain into the Atlantic and Gulf before each hurricane season. Aware of the loss of fresh water needed to recharge the aquifer, the FCD built shallow water conservation areas, but the levees also blocked the natural sheet flow into the lower Everglades. By 1960 the original watershed of 9,000 square miles had been reduced to 3,000.

Table 1.—Major estuarine-dependent species taken commercially from estuarine and marine waters of south Florida—five year average (1966-1970)

Species	Stat. Area 001.0		Stat. Area 002.0		Stat. Area 003.0		Stat. Area 004.0		Charlotte Harbor		Pine Island Sound		Biscayne Bay		Total		Percentage of Grand Total	
	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds*	Value	Pounds	\$
FISH*																		
Striped mullet ( <i>Mullus ocellatus</i> )	7,500	664	1,300	104	1,035,000	72,228	4,263,500	329,895	1,257,100	100,159	2,465,300	205,963	15,420	1,565	9,042,120	710,578	24.85	6.98
Spanish mackerel ( <i>Scomberomorus maculatus</i> )	1,371,600	160,374	296,000	34,393	512,700	58,570	1,027,600	119,154	27,000	2,990	571,900	6,772	18,740	2,254	3,311,540	384,507	9.10	3.78
Spot ( <i>Cynoscion nebulosus</i> )	103,200	32,373	9,000	2,676	70,700	21,339	584,300	167,646	81,400	22,868	651,100	184,395	9,040	3,182	1,508,740	434,479	4.15	4.27
White mullet ( <i>Mugil curema</i> )	348,000	28,083	30,500	2,804	72,600	4,334	157,200	9,454	7,900	408	24,200	1,582	194,000	19,009	834,400	65,674	2.29	4.90
Florida pompano ( <i>Trachinotus carolinus</i> )	132,800	110,907	41,700	33,061	55,000	45,108	231,600	205,584	9,900	7,429	93,900	86,218	15,140	13,217	580,040	498,524	1.59	4.90
Red drum ( <i>Sciaenops ocellatus</i> )	600	91	(1)		14,200	1,934	193,400	29,718	32,100	4,712	98,800	15,468	580	127	339,680	52,050	.93	.51
Crescent jack ( <i>Caranx hippos</i> )	3,600	103	4,900	152	96,200	2,901	94,400	2,529	16,300	327	53,300	1,454	1,320	76	270,020	7,542	.74	.07
Gray snapper ( <i>Centroloides griseus</i> )	25,300	6,583	100,400	25,382	3,000	562	59,800	10,760	5,200	969	46,100	7,707	5,600	1,625	245,400	53,588	.67	.53
Sheepshead ( <i>Archosargus probatocephalus</i> )	2,100	227	100	12	17,900	1,705	66,300	6,057	23,300	1,977	32,400	2,798	1,340	198	143,440	12,974	.39	.13
Mojarra ( <i>Various species</i> )	(1)				2,500	242	39,800	3,478	35,400	3,013	15,700	1,420			93,400	8,153	.27	.08
Sand seatrout ( <i>Cynoscion arenarius</i> )					11,200	1,130	26,900	2,404	2,000	239	15,400	1,657			55,500	5,430	.15	.05
Gulf menhaden ( <i>Brevoortia tyr.</i> )					26,200	525	18,100	764			2,200	167			46,600	1,456	.13	.01
Black drum ( <i>Pogonias cromis</i> )	100	10	(1)		8,800	430	11,700	603	6,200	288	1,200	65	1,920	326	29,920	1,822	.08	.02
Spot ( <i>Leiostomus xanthurus</i> )	(1)				400	42	8,000	631	6,300	497	600	45	20	4	15,320	1,219	.05	.01
Parrot ( <i>Trachinotus falcatus</i> )	400	35	900	99	1,300	146	3,700	407	200	21	3,600	404			10,100	1,112	.03	.01
Less snapper ( <i>Paralichthys oblongus</i> )	1,100	207	4,700	817	(1)		100	31							5,900	1,055	.02	.01
UNCLASSIFIED:																		
For food	46,000	2,772	39,700	2,515	48,100	4,205	284,200	24,953	5,600	494	328,300	29,366	8,660	1,042	860,560	65,437	2.09	.64
For miscellaneous purposes	27,800	1,512	4,200	222	5,200	165	37,500	1,088			18,600	544	420	9	94,420	3,451	.26	.03
FINFISH TOTAL	2,070,100	343,941	533,400	102,238	1,981,800	215,566	7,108,100	912,156	1,515,900	146,491	3,908,600	546,025	269,200	42,634	17,387,100	2,303,051	47.79	22.67
SHRIMP*																		
Pink shrimp ( <i>Penaeus duorarum</i> )	190,000	68,290	14,716,300	6,390,822	1,021,900	522,490	621,700	358,554	400	171					16,550,300	7,340,327	45.49	72.08
Blue crab ( <i>Callinectes sapidus</i> )	(1)		300	55	70,900	6,553			781,300	55,603	768,900	54,728	3,440	978	1,624,840	117,917	4.47	1.16
Stone crab ( <i>Menippe mercenaria</i> )	102,300	50,276	137,700	68,756	530,600	270,979	7,400	3,047					42,180	22,348	820,180	416,106	2.25	4.09
SHRIMP TOTAL	292,300	118,566	14,854,300	6,459,633	1,622,400	800,022	629,100	361,601	781,700	55,774	768,900	54,728	45,620	23,326	18,995,320	7,874,350	52.21	77.32
GRAND TOTAL	2,362,400	463,207	15,387,700	6,561,871	3,605,200	1,015,588	7,737,200	1,273,757	2,297,600	202,265	4,677,500	600,753	314,820	65,960	36,382,420	10,183,401	100.00	100.00

\* Weight as landed (may be whole or gutted); shrimp = heads on

† Common names after Bailey, et al (1970)

(1) Less than 100 pounds

The greatest impact of alteration of natural drainage is the intensified effect of naturally recurring droughts. Heavy summer rains and an occasional hurricane flood the Everglades, but these sources of water are intermittent and less important ecologically than water flow from the north (Tabb, 1963, 1966; Idyll, 1969). The flora and fauna are adapted to naturally occurring droughts of about two years duration, but the periods of stress are prolonged when superimposed on reduced freshwater flow from the north. For example, the "hydroperiod," that portion of the year when marshes are flooded by fresh to slightly brackish water, formerly lasted nine months or longer in average years but now extends only from June to November on the average. This period is of prime importance to the production of commercial and sport fish, because only during this time is there adequate surface water for spawning and survival of forage species (Tabb, 1966).

The result of reduced freshwater runoff has been an increase in estuarine salinity. Estuarine areas such as White-water and Coot Bays were formerly of intermediate salinity (about 20 ppt) but now reach 40 ppt during the dry season in winter (Heald, 1970). In Florida Bay hypersaline conditions are more acute. Formerly, hypersalinity (up to 70 ppt—about twice normal seawater) occurred only during severe droughts but now exists for most of the year in some areas of the Bay (Tabb, 1963; Heald, 1970).

Commercial and sport fish production can be seriously reduced if such prolonged hypersaline conditions become widespread. Based on evidence provided in Emery et al (1957), Tabb (1963) suggested that more than half of the marine invertebrate species normally found in Florida Bay will either be killed or forced to migrate when salinity reaches 60-70 ppt. Tabb further noted that turtle grass (*Thalassia testudinum*), the dominant primary producer in Florida Bay, is severely limited at these salinities and concluded, "It is entirely likely that most

of the desirable sport and commercial fish and shellfish will be run out of the region when salinity values of 60 parts per thousand or higher prevail."

Less severe increases in salinity such as that now occurring in White-water and Coot Bays may also reduce commercial and sport fish production. By allowing a continual increase in salinity, some of the most valuable qualities of the estuary are lost (Odum, 1970). One of the most significant is the loss of protective nursery areas for juveniles, as increased salinity allows entrance of additional marine predator species that would otherwise be excluded because of their intolerance of lowered salinity. Also lost are the means by which young fish and shrimp find their way into the nursery areas. Odum refers to these as the "salinity transport mechanism" and the "dissolved organic road map." By responding to salinity changes occurring during the tidal cycle, young pink shrimp with little swimming ability are able to take advantage of tidal currents to enter the estuary. By orienting towards waters high in organic content, such as that flushed from the estuary, young shrimp and fish are able to migrate into the nursery grounds.

### Domestic and Industrial Pollution

Much of south Florida's estuarine zone is located in Everglades National Park, far removed from population centers, and is relatively free of man's domestic and industrial pollution (Kolipinski and Higer, 1969; McNulty, Lindall, and Sykes, 1972). In fact, water quality in estuarine waters of the Park and lower Biscayne Bay is considered comparable to surface waters of the United States in the early 1900's (DeSylva, 1970; U.S. Department of the Interior, 1971).

Other water bodies of south Florida have not fared so well. A prime example is the overenrichment now occurring in Lake Okeechobee, the heart of the region's freshwater resource. Owing to the channelization of the Kissimmee

River, which drains into Lake Okeechobee, the Kissimmee basin has experienced large-scale marsh loss and has lost much of its capacity to absorb fertilizing materials during runoff. These elements are now transported directly into the Lake, which is predicted to become eutrophic within the next 5 to 10 years (Marshall, 1971). Also, on the densely populated southeast coast, large volumes of untreated or partially treated effluents from domestic, industrial, and agricultural sources are released into numerous canals causing an excessive population of coliform bacteria and also causing periodic plankton blooms (National Academy of Sciences, 1970). Such inadequate treatment of effluents is the general rule in most of Florida's municipalities, and detrimental effects on the estuary can be longlasting, even after abatement. For example, in northern Biscayne Bay pollution was abated in 1956, but several years later commercial and sport fishing had not improved. Many effects of pollution were still present (McNulty, 1970).

### Pesticides

Evidence of pesticide contamination has been found even in pristine areas of south Florida. Surface waters in Everglades National Park contain an average of 0.02  $\mu\text{g/l}$  of DDT and its metabolites, and sediments in the Shark River Slough and nearby canals contain concentrations 1,000 times greater than overlying waters. Mosquitofish (*Gambusia affinis*) in the same areas contain these pesticides in their tissues at a level of 4 orders of magnitude greater than the surrounding water (Kolipinski and Higer, 1969; National Academy of Sciences, 1970).

Presently, the effects of pesticides on the fisheries of south Florida are poorly understood, but the sublethal effects are known to be harmful. For example, DDT at sublethal levels can affect survival of some fish by reducing their ability to escape predation as well as affecting their ability to acclimate to thermal changes in the environment



(Above.) Example of a natural vegetated shoreline. Such waters provide valuable nursery areas for several kinds of fishes important in the sport and commercial catches.

(Right.) A similar area after bulkheading. Bulkheading is one of man's activities that can pose a threat to our estuarine areas.



(Odum, 1970). The latter effect is especially alarming in view of increased use of atomic-generated electric power with its concomitant increase in volume of heated water discharged into the estuarine ecosystem. Nationally, pesticides are already significantly reducing production of estuarine fish and shellfish (Butler, 1969 in Odum, 1970) and in combination with heated effluents from power plants, production of commercial and sport species could be reduced even further.

### Thermal Addition

South Florida's climate is unique in the United States in that its land and fresh water are subtropical in nature, while its estuarine and marine waters are essentially tropical (Hoover, 1969). Typical air and water temperatures are between 26 and 31°C in the summer and between 15 and 25°C in the winter with an occasional frost (Idyll, 1969). In freshwater marshes of Everglades National Park, temperatures often reach 35°C during the summer and have occasionally gone to 38°C (U.S. Department of the Interior, 1971). Likewise, in shallow estuarine areas such as southern Biscayne Bay, August temperatures commonly exceed 35°C (Nugent, 1971). Life processes of fishes inhabiting these waters are geared to seasonal oscillations in water temperature, and many species are presently living within a few degrees of their upper lethal limit in the summer (Hoover, 1969). Thus, an increase of only a few degrees may easily reduce the survival rate of estuarine-dependent species.

Presently, little information is available on the ecological effects of thermal addition in estuaries, but studies in progress will help to provide needed data. In south Florida the effects of the Florida Light and Power plant at Turkey Point in southern Biscayne Bay are under study at this time. Until recently, this plant had two conventional units in operation that raised the daily average temperature across the condenser 5 to 6°C with a range from about 3°C in early morning to about

8°C in the evening (Nugent, 1971). Two nuclear units have been constructed at the site and are producing a limited amount of power. Because they are less efficient than conventional plants, it is expected that the average rise in temperature across the condenser will be 7 to 8°C when the nuclear plants are put into full operation (Roessler and Zieman, 1970).

Preliminary results of the Turkey Point studies showed heated effluent is degrading a portion of southern Biscayne Bay. Roessler and Zieman (1970) recorded a maximum summer temperature of 40.3°C near the outfall when ambient Bay temperatures were 31 to 32°C and found adverse effects over some 300 acres adjacent to the plant. Of these 300 acres, about 125 acres near the outfall and enclosed within the +4°C isotherm were severely affected; virtually all plants and animals were killed or greatly reduced in number. In the remainder of the affected area, enclosed within the +3°C isotherm, algae had been damaged and the number of fish reduced. In another study, Nugent (1971) described the effects of the heated water on the mangrove habitat through which the effluent flowed. Emphasis of this study was placed on the macrofauna, particularly the fishes. Nugent found that most fishes avoided the heated areas near the effluent canal except during the coldest weather. Gray snapper, the most abundant fish taken in the study, and tarpon (*Megalops atlantica*) exhibited the least response to increase in water temperature of any of the fish. No difference in numbers of these two species could be attributed to operation of the plant. However, other commercial and sport species including the white mullet (*Mugil curema*), fantail mullet (*M. trichodon*), striped mullet (*M. cephalus*), and 3 species of snook (*Centropomus undecimalis*, *C. pectinatus*, and *C. parallelus*) were taken in greatest numbers at the control station during warmer seasons. Kills of blue crab (*Callinectes sapidus*) and grunts (*Haemulon* spp.) occurred in the main dis-

charge canal, and in June 1969, the normally hardy toadfish (*Opsanus beta*) succumbed in the offshore area. The only fish found consistently more abundant in the heated water was the lemon shark (*Negaprion brevirostris*).

Not all of the effects of heated discharge from the Turkey Point plant were detrimental. Some protection was afforded to fishes from a cold kill in January 1970, and sportfishing improved in some areas during the winter owing to increased availability (Nugent, 1970). These benefits, however, are not sufficient to offset the many detrimental effects of thermal addition.

Another and potentially more serious threat to estuarine-dependent fisheries is entrainment of planktonic organisms, including fish eggs and larvae, in the cooling system of the power plant where they are subjected to sudden increase of temperature and marked changes in pressure and turbulence (Nugent, 1970). The degree to which organisms are affected depends on the species present and individual plant design, but a recent study of the Turkey Point plant showed that zooplankton, especially those important in the food chain of Biscayne Bay, were extremely susceptible to damage. Some 80 to 85 percent of the zooplankton passing through the plant in July and August, 1970 were killed, and the abundance and distribution of benthic diatoms, the dominant phytoplankton in the Bay, were affected by the heated effluent (Prager, 1970). With the use of less efficient nuclear plants, more cooling water will be required, and the problem of entrainment will be more acute.

### Dredging and Filling

Much of south Florida's estuarine zone lies within the boundaries of Everglades National Park and has thus far been spared the consequences of dredging and filling. However, many prime fish producing areas outside the Park, such as the Keys and a large

portion of the Ten Thousand Islands, are in private ownership and are subject to alteration. The recent and often illegal destruction of the Keys for trailer parks, subdivisions, and waterfront homesites is symptomatic of runaway development. The phenomenal growth of south Florida's coastal communities will undoubtedly bring even more pressure to develop areas outside the Park.

The effects of dredging and filling are almost inevitably adverse and may be permanently destructive to the estuarine environment. Odum (1970) summarized generalized effects of this type of development and pointed out that about three acres of submerged bay bottom are required to create one acre of filled land. Destruction is, therefore, not limited to only the bottom covered by the fill. Areas from which the fill material is taken are often dug to depths below the photic zone; thus, light-requiring benthos are unable to exist. Moreover, silt, sewage, and other pollutants readily accumulate in the dredged depressions, and the resulting anoxic conditions at the bottom have a permanent adverse effect on aquatic life. Studies by Taylor and Saloman (1968) of dredging and filling in Boca Ciega Bay, Fla., showed that sediments in dredged canals averaged 92 percent silt and clay, whereas sediments in undredged areas averaged 94 percent sand and shell. Soft sediments in the canals contained large quantities of organic muds that reduced oxygen levels, and even after 10 years very little recolonization by benthic forms took place. Loss of fishery products from Boca Ciega Bay as a result of dredging and filling was estimated at 73 metric tons (80 short tons) per year. Another example of permanent adverse effects of dredging is found in Biscayne Bay. A deep area dredged in the south part of the Bay almost three decades ago is anoxic and barren today, even though little sewage presently enters the Bay (Odum, 1970).

Building a bulkhead along a vegetated shoreline and filling the vegetated

area behind the wall comprise another method used to create waterfront real estate. This method is common in Galveston Bay, Texas (Mock, 1966), and is a lucrative one for developers of the mangrove-lined shores of south Florida. Such alteration leads to elimination of the intertidal zone along the marsh and mangrove—frequently the most productive portion of the estuary. Adjacent, shallow, subtidal areas are also often eliminated, because sediment is pumped from them to provide fill material behind the bulkhead or to create channels for boat traffic to and from deeper water (Odum, 1970). Mock (1966) compared a bulkhead area with a natural shoreline in Galveston Bay and found that both areas were similar in hydrology and sediment types, but that the natural area supported several times as many shrimp as did the altered area. He concluded that the difference was due to the physical alteration of the habitat which eliminated a natural band of organic detritus, reduced the organic content of the sediment, and deepened the water. Construction of bulkheads in south Florida would have similar effects and would undoubtedly seriously affect commercial and sport fisheries in the region by destroying nursery grounds of many species.

Public indignation over indiscriminate dredging and filling of our estuaries has produced recent legislative action to conserve and protect natural resources that remain (Bellinger, 1970; Linton and Cooper, 1971; McNulty, Lindall, and Sykes, 1972). Faced with statutory restraints, developers are devising alternate methods of creating waterfront home sites to satisfy public demand. One method is the construction of access canals leading from upland acreage to open water. As with bayfill canals, these upland canals are often designed without regard to fish and wildlife resources. Most are constructed with dead ends and dug to depths below the photic zone which create stagnant pockets of stratified water that are at times uninhabitable for fishes because of the lack of dis-

solved oxygen (Lindall, Hall, and Saloman, 1973). Such waters additionally create public health hazards that threaten adjacent estuarine areas and underground water supplies. For example, in a recent study of saltwater canals in the Tampa Bay area ranging from Weeki Wachee south to Punta Gorda, a majority of the canals were found to contain populations of coliform bacteria and *Clostridium perfringens*, the common cause of gas gangrene, in excess of federally approved State standards for body contact (Barada and Partington, 1972). In the same report, data and comments regarding conditions of canals in south Florida indicated:

1. Broward County - "... practically every canal in the county will exceed state standards for coliform contamination and, therefore, are unsafe for body contact."

2. Dade County - "Health problems can be expected in many of Dade's waterways ... records show high MPN counts in many waterways. Several lakes have received much publicity because of eutrophication. With ideal conditions some of the blue-green algae can become toxic to animals. So far, there have been no records of human deaths. Reports of skin rash have been noted ... Botulism, type C, is common in Dade County. Many birds have been killed by this toxin. Health problems occur with the occurrence of dead fish and animals in public waterways ... Fish taken from Dade's canals at times appear to be undesirable for eating. Proper cooking should eliminate any danger involved, although the taste may be somewhat unpleasant (muddy)."

## CONCLUSIONS

The estuarine zone of south Florida is a living, dynamic system made up of extremely complex interactions of wind, rainfall, freshwater runoff, tides, temperature, salinity, currents, sediments, nutrients, and fauna and flora. Cyclic floods, drought, and fire have periodically affected the ecosystem, but it has responded with remarkable

resiliency, and the flora and fauna have adapted to such change. Physical and chemical alterations by man have compounded the natural stresses, however, and thereby greatly modified the natural processes to which the fauna have adapted. Among the fauna threatened by the changes are the estuarine-dependent marine fishes that support multimillion dollar commercial and sport fisheries.

Though much remains to be learned of the dynamics of the estuaries, the value of the ecosystem, economic and aesthetic, is now recognized, and steps are being taken to conserve vital areas. Especially encouraging are proposals at the State and National levels for purchase of the Big Cypress watershed to insure an adequate water supply to a portion of the Everglades National Park. To insure protection of other south Florida estuarine areas, however, present statutes prohibiting further alteration of estuaries and shoreline must be rigorously enforced. If alterations of the estuarine ecosystems with their dire consequences are allowed to continue in south Florida, as they have in the past, the fish resources of this region will continue to be threatened.

## ACKNOWLEDGEMENT

This article was written primarily from a review of the literature and represents a summary of NMFS work on the South Florida Environmental Project, a multiagency program designed to define all aspects of the south Florida ecosystem. I thank Lloyd Johnson, NMFS Supervisory Reporting Specialist, Miami, Fla., and his assistant Ernest Snell for their patience and help in providing catch statistics.

## LITERATURE CITED

- Bailey, R. M. (chairman). 1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. 6, 149 p.
- Barada, W., and W. M. Partington. 1972. Report of investigation of the environmental effects of private waterfront canals. Environmental Information Center of Florida Conservation Foundation, Inc., Winter Park, Fla., 63 p., Appendices.
- Bellinger, J. W. 1970. Dredging, filling and the inalienable public trust—the future of Florida's submerged environment. Bur. Sport Fish. Wildl., 25 p. (mimeo). (From paper presented at 24th Annu. Conf. Southeast Assoc. Game Fish Comm., 1970.)
- De Sylva, D. P. 1970. Ecology and distribution of postlarval fishes of southern Biscayne Bay, Florida. Progr. Rep. to Environmental Protection Agency, Univ. Miami (Mimeo), 198 p.
- Emery, K. O., and R. E. Stevenson. 1957a. Estuaries and lagoons. I. Physical and chemical characteristics. In J. W. Hedgpeth (editor), Treatise on marine ecology and paleoecology, vol. 1, p. 673-693. Geol. Soc. Am. Mem. 67.
- . 1957b. Estuaries and lagoons. III. Sedimentation in estuaries, tidal flats and marshes. In J. W. Hedgpeth (editor), Treatise on marine ecology and paleoecology, vol. 1, p. 729-749. Geol. Soc. Am. Mem. 67.
- Florida Department of Natural Resources. 1971. Outdoor Recreation in Florida. A comprehensive program for meeting Florida's outdoor recreation needs. State of Florida Dep. Nat. Resour., Div. Recreation and Parks. Tallahassee, Fla., 349 p.
- Heald, E. J. 1970. The Everglades estuary: an example of seriously reduced inflow of water. Trans. Am. Fish. Soc. 99:847-848.
- Hedgpeth, J. W. 1957. Estuaries and lagoons. II. Biological aspects. In J. W. Hedgpeth (editor), Treatise on marine ecology and paleoecology, vol. 1, p. 693-729. Geol. Soc. Am. Mem. 67.
- Higman, J. B. 1967. Relationships between catch rates of sport fish and environmental conditions in Everglades National Park, Florida. Proc. Gulf Caribb. Fish. Inst., 19th Annu. Sess., p. 129-140.
- . 1969. Studies of the dynamics of the fish stocks in the Everglades National Park—X. 1968-1969. Annu. Rep. Univ. Miami (typewritten), 10 p. plus Appendix.
- Hoover, H. W., Jr. (chairman). 1969. Report of the committee on inshore and estuarine pollution. The Hoover Foundation, N. Canton, Ohio, Proc. Rep., 21 p.
- Idyll, C. P. 1965. Freshwater requirements of Everglades National Park. Fla. Nat. 38(3):97.
- . 1969. The Everglades: a threatened ecology. Sci. J. 5A(2):66-71.
- Kolipinski, M. C., and A. L. Higer. 1969. Some aspects of the effects of the quantity and quality of water on biological communities in Everglades National Park. U.S. Geol. Surv., Open-Field Rep. (mimeo), 97 p.
- Lindall, W. N., Jr., J. R. Hall, and C. H. Saloman. 1973. Fishes, macroinvertebrates, and hydrological conditions of upland canals in Tampa Bay, Florida. Fish. Bull., U.S. 71:155-163.
- Linton, T. L., and A. W. Cooper. 1971. Damaged estuarine ecosystems, their restoration, and recovery. ASB (Assoc. Southeast. Biol.) Bull. 18:129-136.
- Marshall, A. R. 1971. A review of water resource projects and problems in Central and South Florida. Statement for presentation to the Governor and Cabinet of Florida, 13 April 1971, 6 p. (mimeo).
- McNulty, J. K. 1970. Effects of abatement of domestic sewage pollution on the benthos, volumes of zooplankton, and the fouling organisms of Biscayne Bay, Florida. Stud. Trop. Oceanogr. (Miami), 9, 107 p.
- McNulty, J. K., W. N. Lindall, Jr., and J. E. Sykes. 1972. Cooperative Gulf of Mexico estuarine inventory and study, Florida: Phase I, Area description. U.S. Dep. Commer., NOAA Tech. Rep. NMFS CIRC-368, 126 p.
- McQuigg, J. L. 1971. The economic value of Florida's estuarine areas. Lecture presented at the estuary seminar of Pine Jog Environmental Science Center, W. Palm Beach, Fla., May 6, 1971, 9 p. (mimeo).
- Mock, C. R. 1967. Natural and altered estuarine habitats of penaeid shrimp. Proc. Gulf Caribb. Fish. Inst., 19th Annu. Sess., p. 86-98.
- National Academy of Sciences. 1970. Environmental problems in South Florida. Report of the Environmental Study Group to the Environmental Studies Board of the Natl. Acad. Sci., Natl. Acad. Eng. Part II. Reproduced by U.S. Dep. Commer., N.T.I.S., PB 159, 75 p.
- Nugent, R., Jr. 1970. The effects of thermal effluent on some of the macrofauna of a subtropical estuary. Univ. Miami, Sea Grant Tech. Bull. 1, 198 p.
- Odum, W. E. 1970. Insidious alteration of the estuarine environment. Trans. Am. Fish. Soc. 99:836-847.
- Prager, J. E. 1970. A study of Biscayne Bay plankton affected by the Turkey Point thermoelectric generating plant during July and August 1970. Fed. Water Qual. Admin., Natl. Mar. Water Qual. Lab., Kingston, R.I., 186 p. (mimeo).
- Roessler, M. A., and J. E. Zieman, Jr. 1970. The effects of thermal additions on the biota of southern Biscayne Bay, Florida. Proc. Gulf Caribb. Fish. Inst. 22d Annu. Sess., p. 136-145.
- Tabb, D. C. 1963. A summary of existing information on the freshwater, brackish-water and marine ecology of the Florida Everglades region in relation to freshwater needs of Everglades National Park. Univ. Miami, Inst. Mar. Sci. Rep. ML-63609, 153 p.
- . 1966. The effects of changes in water supply in marshes on the species composition of fishes. Annu. Rep. to Bur. Sport Fish. Wildl., Contract No. 14-16-0004-56. (mimeo), 41 p. Univ. Miami.
- Tabb, D. C., and C. P. Idyll. 1964. Summary of evidence supporting the contention that Everglades National Park depends on supplies of fresh water for its existence. Mimeo. Rep., Inst. Mar. Sci., Univ. Miami, Oct. 1964, 9 p.
- Taylor, J. L., and C. H. Saloman. 1968. Some effects of hydraulic dredging and coastal development in Boca Ciega Bay, Florida. U. S. Fish. Wildl. Serv., Fish. Bull. 67:213-241.
- U.S. Department of the Interior. 1971. Appraisal of water quality needs and criteria for Everglades National Park. Natl. Park Serv., Wash., D.C., June 1971, 50 p.

MFR Paper 1013 from Marine Fisheries Review, Vol. 35, No. 10, October, 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.

## Schoning: Prices; Foreign Fishing; Underutilized Species; Aquaculture

Shortly after having been sworn in as Director of the National Marine Fisheries Service, Robert W. Schoning met informally with John A. Guinan, NOAA Public Affairs Officer assigned to the National Marine Fisheries Service, for a wide-ranging discussion of U.S. fish and fisheries. The following article presents highlights of the interview.

*Guinan: Probably the most talked about fisheries topic these days is prices.*

Schoning: Prices are a real problem. I hear this often from my wife. And people throughout the industry are concerned.

*Guinan: Why have prices shot up?*

Schoning: Because of increased demand, both foreign and domestic, and the reduction in availability of some of the more popular stocks of fish.

*Guinan: What is the outlook on prices?*

Schoning: I think they will generally stay high, possibly even go up, for some time.

*Guinan: The United States imports about 65 or 75 percent of its fishery products. Why?*

Schoning: The demand for fishery products exceeds the domestic catch. The demand is increasing. Our fishermen are unable at this time to capture enough marketable fish to satisfy it. Because of various foreign government subsidies and for other reasons, many imports are available on our markets at a cheaper price than domestic species.

*Guinan: We can expect increasing reliance on imports, then?*

Schoning: I hope the trend will change. We in NMFS are determined to cooperate closely with our fishing industry in helping it capture a greater share of the U.S. market. We are convinced that this can be done and should be done. Our fishermen have the technical competence to capture more fish. But the amount and type of foreign fishing activity off our coasts prevent our fishermen from being as productive and effective as they might be. We must develop more of our presently

underutilized species. In addition, we must take a greater percentage of the total fish caught off our coasts. This means, very clearly, that we must reduce the foreign catch in the waters off the United States.

*Guinan: Foreign fishing, you seem to agree, is a major threat to the U.S. fishing industry.*

Schoning: There is no question about that. They are not now taking great quantities of *all* the species available. But I am convinced that unless some more positive action is taken to deter them, eventually they will fish on those other stocks as well. Something must be done to stop it.

*Guinan: What is NMFS doing about this?*

Schoning: We are working through bilateral and multilateral agreements with these nations.

*Guinan: Has this been successful?*

Schoning: Yes, in some areas, and we are continually working to improve them. In the recent ICNAF (International Commission for North Atlantic Fisheries) discussions, the United States took a much firmer position than in the past. I think this is a very definite trend that will continue. The United States must stand up to be counted. We are tightening up our demands for more consideration for our fishermen in bilateral and multilateral agreements and conventions, such as ICNAF.

Also, with considerable help from leaders of the U.S. fishing industry, we are pushing hard for a position in the Law of the Sea discussions that will give appropriate consideration to our U.S. fisheries.

Robert W. Schoning, Director of the National Marine Fisheries Service, NOAA, right, is interviewed by John A. Guinan, NMFS Public Affairs Officer, for *Marine Fisheries Review*.



*Guinan: We import about \$1.3 billion more fish and fishery products than we export. Foreign nations are becoming more affluent; they are eating more fish, and the dollar has been sinking in value. How will these developments affect the U.S. fisheries?*

Schoning: I think it inevitable that there will be increased competition of serious concern to the U.S. fishing industry. But that can be turned to our advantage. Many of our processors are expanding their capabilities with the addition of foreign capital. If the dollar continues to sink in value and the demand for fish increases in the nations which catch the fish—and I am sure the latter will occur—it will tax the ingenuity of the U.S. commercial fishing industry. There will be some problems, some very difficult ones. But I am convinced the industry will respond in a meaningful way and by such action will retain a viable U.S. commercial fishing industry to supply our consumers with the fish they deserve and want.

*Guinan: We often hear that certain segments of the fishing industry are "sick". Which are these?*

Schoning: Most, if not all, fisheries have problems. But those I consider "sick" are the ones where there has been very heavy foreign fishing encroachment on the stocks. For example, in New England, for a hundred years or more our fishermen have fished the stocks and caught large numbers of fish. But they have been able, by their fishing practices, to keep the stocks on a good producing basis. But the very large foreign effort has reduced many stocks to a point where we can no longer make a reasonable profit from fishing them.

*Guinan: Will this situation continue?*

Schoning: They are going to stay in this condition until—in my judgment, at least—the foreign effort is either

eliminated entirely for certain species or very sharply restricted. And a considerable period of time must be given to bringing these stocks back. Certainly the New England ground fishery is in this category. Some off the west coast are, too, such as Pacific Ocean perch off Washington and Oregon and some of the groundfish in Alaska.

*Guinan: What are some "healthy" fisheries?*

Schoning: The tuna fishery is very "healthy"—at least the Pacific tuna—although the increased foreign effort with accompanying disregard of regulations and the expanding program in vessel construction are causing us great concern on a worldwide basis. Shrimp, as a whole, is also "healthy."

*Guinan: You have mentioned underutilized species. Is NMFS doing anything about them?*

Schoning: A considerable amount, and we hope to do more. Our scientists have accumulated information regarding certain species that they think are in sufficient abundance to justify long-term commercial fisheries. We are making plans to embark on exploratory, harvesting, and marketing programs on certain of these species.

*Guinan: Which ones?*

Schoning: We have one project underway right now with Jonah crab and red crab and squid in New England. We are also considering working with ocean quahog—a large clam—and with croakers in the Gulf. Another species is pollock in the Bering Sea. There is considerable industry cooperation in such efforts and that is the way we like to go.

*Guinan: How do you sell such little-known products?*

Schoning: Our marketing people are working on that. Marketing plays a key role in the work in New England.

One of the things that has stimulated this program has been keen industry interest in the foreign markets for squid.

We generally believe that there is a place for NMFS to be involved in marketing and developing markets for underutilized species, developing export markets for species not yet popular in the United States, and developing methods to present the product in a palatable way and make people aware of it.

*Guinan: How about aquaculture?*

Schoning: I am convinced that aquaculture can contribute substantially to our supply of protein. Although I'm not sure that large, tangible benefits will come as quickly as some of the more hopeful people believe.

*Guinan: What is NMFS's part in the aquaculture picture?*

Schoning: I feel that NMFS should do much of the research to demonstrate that certain approaches are possible and realistic. Once we do develop techniques and procedures, then our knowledge should be turned over to private industry for further use.

*Guinan: What are some of the species NMFS is working on?*

Schoning: Pan-size salmon, shrimp, and other shellfish.

*Guinan: Is the public being kept informed about results?*

Schoning: We are trying to publish results as quickly as possible in appropriate scientific journals. We are also communicating the results to industry and others who might find them of use.

*Guinan: Are there major roadblocks in the way of developing aquaculture?*

Schoning: A number. For example—and this is one that people don't normally think of—if a particular type of aquaculture requires a substantial number of ponds for rearing,

there are some real problems. Water-front acreage and the taking away of large water areas for this purpose is becoming prohibitive both from the standpoint of cost and availability. Some companies are going to foreign countries where the land associated with water is more readily available. Developing or finding an acceptable food for the young is another problem.

*Guinan: How do NMFS's efforts in aquaculture interact with those of other agencies?*

Schoning: I think that there will be a very significant part in the aquaculture future for NMFS, NOAA, private industry, the States, and the universities. The more coordinated cooperation we can get in this challenging program, the more productive we can be and the quicker we can utilize the results. We are working with many now.

*Guinan: Do you believe NMFS has a responsibility to conduct research*

*and development on different—even revolutionary—fishery gear and methods?*

Schoning: I am convinced we should do more of it.

*Guinan: NMFS is probably the largest single employer of fishery biologists in the world. What would be your advice to a student entering this field?*

Schoning: I think the individual should be keenly interested in the work itself. The monetary benefits should be secondary. The person should be dedicated to working hard.

*Guinan: Is the Ph.D. a requisite?*

Schoning: No. As a prospective employer, I would be more interested in hiring someone with a well-rounded background—with a college degree, but who has attributes such as a determination to work hard, a willingness to cooperate, ingenuity, a desire to

accept responsibility and to make decisions. To me, these are more important than the additional academic training as such. Certainly, I don't mean that additional educational training is not valuable. It is very valuable.

*Guinan: Are there particular courses you think prospective employees should take?*

Schoning: Yes. I would strongly urge the people to take additional training in writing and public speaking.

*Guinan: What about employment opportunities for women?*

Schoning: They are good.

*Guinan: At the professional level?*

Schoning: At the professional level. For example, a well-known fisheries technologist, Mary Thompson, is Deputy Director of our Southeast Fisheries Center in Miami. This is a key position. She is doing a fine job. There are others, too.

*Guinan: There are about 9.5 million sport fishermen who seek marine fish. What is their estimated catch?*

Schoning: When you consider only edible saltwater fish, their catch is close to two-thirds the commercial catch. And the recreational catch figures do not include shellfish. We do not have a fix on the amount of shellfish caught by recreational fishermen.

*Guinan: How is NMFS seeking to improve recreational fishing?*

Schoning: In the past, most of our effort has been directed toward some of the more exotic species known to be

Sport fishermen catch nearly two-thirds the edible commercial marine fish catch according to Director Schoning.



fished by ocean big game fishermen. These would be the billfishes and some of the sharks. We are going to concentrate our effort more along the lines of research, trying to get basic needed information about the life history and habits and abundance and numbers caught of these and other species—species of importance to the people who don't go so far to sea to fish but fish closer to or from the shore.

We plan to work with the introduction of Pacific salmon in New England. We are very hopeful that this will develop into a real fine sport fishery.

*Guinan: You have mentioned several interesting developments. How do people get more information about them?*

Schoning: The simplest way is to contact our people in the regions. We have people spread out all over the nation. Or you can contact the Washington office.

*Guinan: What is the NMFS role in the Great Lakes?*

Schoning: We are out of the biological research work there, but commercial fishing and certain associated activities are still our responsibility.

*Guinan: The Marine Mammal Protection Act became law in December 1972. What is NMFS doing under it?*

Schoning: In Commerce we have the responsibility for whales, porpoises, seals, and sea lions. The purpose of the Act, essentially, is to prohibit the capture and importation of marine mammals and marine mammal products. We have a very active part in administering the act.

Some of the most significant research work, both in biological and gear research, recently has been done on the incidental capture of porpoises in the yellowfin tuna fishery. We are trying

to develop procedures and gear and techniques to reduce or eliminate this incidental killing of porpoises. The work looks promising.

*Guinan: What about the fur seal program in the Pribilof Islands?*

Schoning: The Act very clearly exempts the long-standing program of harvesting fur seals in the Pribilof Islands. This is one of the classics of marine mammal management. It has been going on since before the turn of the century. It is sound, well planned, and coordinated.

*Guinan: A few personal questions at this point, please. Do you like to fish?*

Schoning: Yes, although I haven't done as much of it lately as I would like to. In coming from the Pacific Northwest, where I spent essentially my entire life, I confined my fishing primarily to salmon and some miscellaneous salt-water species.

*Guinan: What is your favorite eating fish?*

Schoning: Pacific salmon. There is no question in my mind about that. I have eaten it for a great many years. I have tried fish all over the country. Although I like a great number of them, I'm still very partial to Pacific salmon, particularly when it's fresh and broiled.

*Guinan: Any specific recipes?*

Schoning: No, that's handled by other members of the family. I just eat it, enjoy it, and leave the cooking to the experts.

*Guinan: Have you tried any of the underutilized species?*

Schoning: For a recent meeting where we made a presentation to the

President's Cost of Living Council Subcommittee on Food our staff prepared a number of dishes from underutilized species. I practically devoured the entire supply of squid myself. It was marinated and it was very delicious. As I recall, this was my first exposure to it, and I hope it will not be my last. There are some other underutilized species—Jonah crab, red crab, and dogfish—I have tried in the past and liked.

*Guinan: Do you plan close cooperation with other agencies and organizations interested in marine fisheries?*

Schoning: Yes. I am determined that we will make an even greater effort in NMFS to solicit and carefully evaluate and incorporate, where appropriate, the views of our constituency at an early stage in the development of our programs. I include among our constituency the sport fishery interests, the commercial fishing industry, State agencies, other Federal agencies, the universities, and conservation groups. I expect to hold their feet to the fire in providing us their views as we go along in developing and implementing our programs. We want to get ideas from all these people. We recognize they have expertise, knowledge, good ideas, and we want to make the best use of these. Undoubtedly we will not use all of them but I am confident many will be helpful.

Being appointed as Director of NMFS is a great honor for me and a tremendous challenge. I am very excited about it. I look forward to working closely with all those who have this same goal of more viable and productive commercial and sports fisheries in the United States. With the competent NMFS staff and the help of all other interested parties, I am convinced we can make meaningful progress. We can, we must, we shall.

## Undersized Halibut Fillets Discovered

Notice has been given to importers of halibut from Japan that inspections of several samples of recent imports contained fillets which were determined to be from undersized halibut. The National Marine Fisheries Service has reason to believe that the halibut, from which some fillets were obtained, were caught in contravention of Japanese domestic law including regulations. United States law prohibits the importation of such fillets from undersized halibut which were taken in violation of the laws or regulations of Japan.

The Japanese Government has a 26-inch (66 cm) minimum size limit on halibut caught in the North Pacific Ocean, Bering Sea, and Okhotsk Sea, inclusive, throughout the year. This minimum size limit is identical with the size limits established in the eastern Bering Sea pursuant to the International Convention for the High Seas Fisheries of the North Pacific Ocean.

Under the provisions of 16 U.S.C. 851-856, inter alia, it is unlawful for any person to deliver or receive for transportation, or to transport, by any means whatsoever, in interstate or foreign commerce, any fish, if such person knows or in the exercise of due care should know that (1) such delivery or transportation is contrary to the law of any foreign country from which such fish is found or transported, or (2) such fish has been either caught,

killed, taken, sold, purchased, possessed, or transported, at any time, contrary to the law of the foreign country, in which it was caught, killed, taken, sold, purchased, or possessed, or from which it was transported. In addition, it is unlawful to purchase or receive any fish, if such person knows, or in the exercise of due care should know, that such fish had been transported in violation of the above.

The National Marine Fisheries Service is now in the process of establishing procedures under which imports will be examined and tests conducted to determine if fillets from illegal fish are contained in the shipment.

In order to avoid a violation of this law, importers of halibut or halibut fillets are accordingly advised to notify their vendors and consignors of this notice and to take such other measures as may be necessary to prevent the importation of undersized halibut or fillets from under-sized halibut from Japan.

## Blum to Manage Sea Mammal Program

The appointment of Joseph R. Blum, 33, as Marine Mammal Coordinator in the National Marine Fisheries Service has been announced by the Commerce Department's National Oceanic and Atmospheric Administration.

The Fisheries Service's responsibilities were greatly expanded by passage of the Marine Mammal Protection Act of 1972 when the Service was assigned the management, enforcement, and administrative functions of that portion of the legislation that deals with seals, sea lions, whales, and porpoises.

NMFS Director Robert W. Schoning said: "We are fortunate to have a man of Mr. Blum's experience and capabilities in this extremely important position. We feel he has special com-

petence because of his training and expertise, especially in situations demanding full cooperation between the various States and the Federal Government."

Mr. Blum's most recent assignment was as Deputy Commissioner of the Alaska Department of Fish and Game in Juneau. He has represented Alaska on a number of State and State-Federal groups working on fish and game problems, particularly on reducing State-Federal conflicts and overlap. Another of his assignments in Alaska dealt with marine mammal habitat with a goal of minimizing or eliminating hazards to marine mammals.

## New Federal Loan Law Aids Fishermen

Certain provisions of the new Federal Ship Financing Act of 1972 are of particular interest to the fishing industry and those who finance fishing vessels, according to the Commerce Department's National Oceanic and Atmospheric Administration.

The Act simplifies paper work, liberalizes refinancing, and makes the program more attractive to lenders who finance commercial fishing vessels. Lenders participating in the new program will no longer have to secure their loans by vessel mortgages or other collateral. The lender will be protected by a U.S. Government guarantee of the obligation. The Government and the borrower will then make security arrangements without the lender's involvement.

Among other things, the Act provides for a Fishing Vessel Obligation Guarantee Program to be administered by NOAA's National Marine Fisheries Service. The new program is designed to increase private financial responsiveness to the investment capital needs of the U.S. commercial fishing fleet.

By guaranteeing obligations such as notes, bonds, debentures, or other forms of indebtedness, the new program assures lenders that they will be repaid as agreed when they make loans

## LORAN-A System To Be Continued

On June 6, 1973, the U.S. Coast Guard issued a notice to mariners stating that it intends to continue the LORAN-A system in the U.S. until a system that is a reasonably adequate replacement is operating. Any changes will be given widespread publicity well in advance and a reasonable period of concurrent system operation will be provided to allow mariners to convert.

to commercial fishermen to help finance or refinance up to 75 percent of the cost of constructing, reconstructing, or reconditioning commercial fishing vessels.

NMFS Director Robert W. Schoning said that if a borrower subsequently defaults in paying a guaranteed obligation, the Commerce Department would pay the lender the obligation's entire unpaid principal and interest balance. He said the full faith and credit of the Commerce Department and the U.S. Government will be pledged to payment of the guarantee. Loans for construction may be for a period of up to 15 years or even longer if circumstances warrant, but terms for reconstruction or reconditioning loans would usually be of shorter duration than those for new vessels.

Mr. Schoning said the new program,

which supersedes the old Fishing Vessel Mortgage and Loan Insurance program, can be used in conjunction with the NMFS administered Capital Construction Fund program. The latter program allows deferment of taxation on certain income from commercial fishing operations when such income is deposited in a Capital Construction Fund for subsequent use in constructing, acquiring, or reconstructing a commercial fishing vessel. Such funds may, for example, be deposited and withdrawn by a borrower to pay installments due on an obligation guaranteed under the Fishing Vessel Obligation Guarantee program.

Mr. Schoning said that all comments and questions concerning the new programs may be addressed to the National Marine Fisheries Service.

## Marine Mammal Progress Is Told

The Commerce Department granted no letters of exemption permitting the commercial killing of marine mammals during the first six months following passage of the Marine Mammal Protection Act of 1972. Secretary of Commerce Frederick B. Dent said on August 1, following release of a progress report on administration of the Act.

Of 50 applications concerning marine mammals submitted during the period covered by the report, the Secretary said, three applications were denied. These applied to two companies engaged in the sale of captured marine mammals in the United States and abroad, and one company whose business was based on the tanning of seal and sea lion pelts.

Applications were withdrawn by one company interested in importing 10,000 sealskins, by another wanting to capture killer whales, and by two scientific researchers. Altogether, the rejected or withdrawn applications concerned about 13,000 animals.

Thirteen exemptions were approved, principally covering the use of living

animals for scientific study or display. The great majority of these animals were tagged for scientific purposes and released back to the wild.

As of mid-June, 30 applications were pending.

The Marine Mammal Protection Act was signed into law by President Nixon on October 21, 1972, and took effect December 21. It establishes a national moratorium on the taking or importation of marine mammal products. It stipulates that a series of legal, scientific, and technological steps be taken in a sustained effort to maintain—and if necessary rebuild—populations of marine mammals. The Secretary of Commerce is responsible for the management and conservation of porpoises, sea lions, seals and whales; the Secretary of the Interior for all other ocean mammals.

Among the actions of major importance taken during the December-June implementation period of the Act, the report notes the following:

Establishing interim regulations governing the granting of exemptions to individuals and organizations.

Establishing a policy governing exemptions to research scientists which recognizes that continuing investigation of marine mammal life-cycles—highly necessary to the broad aims of the Act—depends on the ability of researchers to acquire certain animals.

Establishing a policy regarding exemptions to display organizations (seaquariums and the like) which recognizes the educational and aesthetic values of marine mammal exhibits to the public.

Adopting a policy that exemptions will be granted only to applicants who will maintain control of the animals, rather than collecting them for resale.

Establishing regulations governing handling and maintenance of captive marine mammals to assure their well-being.

Concluding cooperative enforcement arrangements between the Federal Government and ten States whose geographic locations involve them in marine mammal activities.

Creating a collection of abstracts of scientific information on marine mammals, encompassing 66 species.

Setting aside one of the Pribilof Islands off Alaska as a research area for the northern fur seal on which commercial harvesting has been halted for a period of years.

Undertaking a diversified scientific and technological study designed to reduce to the lowest achievable point, porpoise mortality stemming from tuna fishing methods used in the eastern tropical Pacific.

Requiring Environmental Impact Statements when large numbers of individual species are involved.

Proposing cooperative international actions to conserve and protect marine mammals.

## Knecht Heads Coast Environment Office

Robert W. Knecht has been named Director of the Office of Coastal Environment, a unit of the Commerce Department's National Oceanic and

Atmospheric Administration. Mr. Knecht has served as Acting Director of the office since its establishment in May.

The Office of Coastal Environment was formed to manage NOAA's responsibilities under the Coastal Zone Management Act of 1972, the Marine Protection, Research and Sanctuaries Act of 1972 (the Ocean Dumping Act), and related activities. Operating under NOAA's Associate Administrator for Marine Resources, OCE presently consists of the Coastal Zone Management Program, Marine Eco-Systems Analysis (MESA) Program, and Manned Undersea Science and Technology (MUS&T) Program.

"America's coastal areas are immensely productive, often ecologically fragile and much sought after for recreational activities," Mr. Knecht said. "Our aim is to help ensure their continued health, beauty, and productivity for our benefit. Our mission is to encourage and assist the States and other interested groups in the rational planning and coordinated management of these vital but often-neglected areas."

Mr. Knecht was formerly Deputy Director of NOAA's Environmental Research Laboratories, Boulder, Colo., and came to the Washington area in 1972 to head the Coastal Zone Management Task Force. He has been in government service in the Department of Commerce since 1949 as a research physicist in the National Bureau of Standards and later in the Environmental Science Services Administration and in NOAA.

## Tokyo Fisheries Attache is Named

The Commerce Department's National Oceanic and Atmospheric Administration has announced the appointment of Lorry M. Nakatsu, 47, a career employee of the National Marine Fisheries Service, as U.S. Regional Fisheries Attache to Tokyo. He replaces Clinton E. Atkinson who has held the position since 1966 and

who plans to retire in November 1973.

Mr. Nakatsu will be responsible for reporting on fisheries developments, representing the United States at fisheries meetings and activities, assisting the U.S. fishing industry in locating both markets and sources of supply overseas, and reporting on economic, political, scientific, and legal developments on fisheries matters which may affect the U.S. in East and Southeast Asia.

Until recently Mr. Nakatsu headed the Foreign Fisheries Program in the International Activities Staff of NOAA's Fisheries Service, and was responsible for collecting, analyzing, and evaluating information on significant fisheries developments in foreign countries. Earlier in his career, after being graduated from the University of Washington's College of Fisheries

in Seattle, he served as a salmon biologist at the NMFS laboratory in that city. In 1960 he was named head of a newly established program in the NMFS Regional Office at Terminal Island, California, to monitor and analyze the world's tuna fisheries with emphasis on the Japanese fisheries. He was transferred to Washington in 1966 and on a number of occasions participated in fisheries negotiations with Japan, the Soviet Union, and Canada. He also served as an adviser to the U.S. delegation to the International North Pacific Fisheries Commission.

Mr. Nakatsu, who is of Japanese ancestry, has a fluent knowledge of the Japanese language, having served as a linguist with the U.S. forces in World War II and as a translator for nearly four years in post-war Japan.

### Foreign Fishery Developments

## OECD Fish Catch Drops, Imports Gain

The 1972 catch by the fishing fleets of member countries<sup>1</sup> of the Organization for Economic Cooperation and Development (OECD) totaled almost 23 million metric tons, a drop of 400,000 tons from 1971, according to OECD's *Review of Fisheries, 1972*. The total value of this catch will increase by 5 percent to about US \$9.2 billion.

Reflecting rising demand and the increase in landed value, imports of fish products by OECD countries was nearly US\$3.8 billion, up 24 percent from 1971 and their exports gained 20 percent in value to reach US\$2.6 billion. This expansion reflected the movement of greater quantities of many products as well as generally rising prices.

In the first quarter of 1973, markets continued buoyant and prices rose

steadily. With little immediate prospect of larger supplies either of fish or other animal foods, a further build-up of demand pressure is believed likely.

In a period of widespread economic uncertainty such as prevailed in 1972, the continuing expansion of international trade in fish and fish products was notable. The relatively high escalating prices generally paid for fish which were in short supply tended to stimulate fleets to more intensive fishing of many resources which were already heavily exploited. The outcome of a downward trend in vessel catch rates was intensification of management measures which tended to narrow the fishing areas for many countries. The multiplying claims to wider national fishery preserves raised considerable dismay among many major fishing nations.

Intensified demand for high valued shellfish exerted growing pressure on supply which could only be enlarged within limitations and consequently

<sup>1</sup> Australia, United States, Canada, Japan, United Kingdom, Norway, Iceland, Denmark, Portugal, Spain, France, W. Germany, Belgium, Ireland, Italy, Greece, Netherlands, Sweden, Turkey, and Finland.

shellfish prices advanced to record levels on world markets. Most notable were increases in imports of shellfish by France and Japan. Shortages of certain U.S. fillets and blocks caused similar rise in prices for those products. Indications are that per capita consumption resumed its upward trend and would have been more pronounced had supplies of products been available. In practically all countries, an imbalance between supply and demand for protein foods resulted in steep price rises for many agricultural and fishery products.

Improved earnings in the fishing sector were noted even though many of the major catches were less than in previous years. Vessel construction and operating costs continued to increase. Although earnings were favorable, there was no evident reduction in government financial aid given to fisheries. Some reductions were noted in operational subsidies in a few countries but little, if any, reductions were made in the supports provided to shipbuilding. Indications were that more favorable financial returns stimulated more fishermen and vessel owners to take advantage of whatever assistance was available to improve their fishing equipment.

An intensification of international cooperative action showed some progress toward the advancement of fisheries and the conditions under which fisheries are operated. The U.N. Conference on the Law of the Sea continued its extensive preparatory arrangements for the conference scheduled to get under way in 1974. The Sea-Bed Committee provided a forum for most countries to express their views on fisheries jurisdiction and certain lines of agreement were beginning to emerge. The U.N. Conference on Human Environment led to a number of anti-pollution and conservation measures.

International trade by leading countries showed that the United States imports neared US\$1,467 million followed by Japan (\$618 million), the United Kingdom (\$313 million), France (\$227 million), West Germany

(\$174 million), and Italy (\$172 million). The leading exporter was Japan (\$527 million), followed by Canada (\$380 million), Norway (\$363 million), Denmark (\$250 million), and the United States (\$160 million).

## Australian Abalone Exports Expanding

The astonishing expansion of the abalone fishing industry in Australia is the subject of a paper by Dr. D. G. James and Dr. June Olley of the Commonwealth Scientific and Industrial Research Organization, Tasmania. It is to be presented to the forthcoming World Technical Conference on Fishery Products, being convened by the Food and Agriculture Organization of the UN (FAO), in Tokyo from 4 to 11 December 1973 at the invitation of the Government of Japan.

The paper on the abalone points out that in the ten years since the fishery started commercially it has grown in value to US \$10 million a year in export earnings—more than 10 percent of Australia's total export earnings from fishery products.

The abalone, which is a snail-like marine mollusc, is taken by divers who prise it off rock ledges. The commercial fishery is around the coasts of Tasmania, Victoria and South Australia. It has been controlled through the state government fishery departments from the start to conserve stocks.

Divers are licensed and the number permitted to operate in any area is limited. There is also a minimum size limit to protect the young stock so that the fishery is managed in order to ensure that the maximum sustainable yield is not exceeded. Strict quality and hygiene standards are enforced, all processing premises and operations being subject to inspection and regulation by the Commonwealth Department of Primary Industry.

Practically the entire catch is exported in various forms as Australians

have not so far acquired a taste for abalone. The mollusc is produced frozen, canned, and dried. Abalone steaks are also produced. There is, too, a market in Japan for raw abalone for eating as "sushi" and "sashimi". This requires the abalone to be, preferably, delivered alive, which calls for air freight transport. The problems of this are being investigated. As the authors say, "The future of this trade depends on rapid handling and immediate marketing on arrival in Japan".

The paper will be one of about 80 to be presented at the Conference which will review, for the first time, the world situation in the fishery products industries.

## ROK Eyes Fish Lead

The Republic of Korea (ROK) in 1976 plans to increase her fishery production to 2,151,000 metric tons from 1,324,000 tons harvested in 1972, according to the NMFS International Activities Staff. The Republic of Korea, which in 1972 was the twelfth largest fishing nation in the world and the fifth leading fish exporter, in 1976 plans to move ahead to fifth place in output and second place in exports, and in 1981 hopes to become the world's leading fish exporter.

Based on 1960 as 100 percent, ROK fish production in 1972 increased 370 percent in quantity and her fish exports (worth US\$150.8 million) jumped 2,143 percent in value. Fish production target for 1973, set at 1,526,000 metric tons, and fish export target, fixed at \$189 million, represent gains of 426 percent and 2,700 percent, respectively, as compared to 1960. In 1976, ROK plans to export oysters worth \$30-50 million. The ROK Government, which concluded a shellfish sanitation agreement (also includes price agreement) with the United States in November 1972, is placing high priority on oyster cultivation because of the expanding export trade for that product and declining worldwide trend in oyster production due to water pollution.

## Aquaculture in the Soviet Union<sup>1</sup>

The Soviet Union has large natural and artificial inland water reservoirs with which to develop fresh water and subsaline water type farms as the major source of providing the population with fish. Soviet research institutes have also for several years been working on the development of marine fish-breeding. Thus, for instance, they have found a way to breed the kalkan, a Black Sea variety of plaice.

At the present rate of development, the annual fish culture production will reach 30 to 40 million tons by 1980 and account for approximately 65 percent of the total catch of fish in the world.

There are at least two reasons for this fish-breeding "boom." First, the concept of the inexhaustible reserves of fish in the world ocean has proved to be an illusion. And second, the accelerated development of marine biology, ecology, and engineering, makes it possible to turn fish breeding into an intensively developed branch of the economy like cattle breeding, increases productivity many times per area unit, and makes it highly profitable and capable of withstanding competition.

An experimental farm was set up in Posiet bay in the Far East in 1972 to grow and cultivate scallops, oysters, trepang and some other kinds of fish. In the near future this region will become one of the basic sites of the development of marine fish culture in the USSR.

In the Taganrog bay of the Azov Sea and along the Baltic coast, fish have been grown in sea ponds for two years now. Each acre of the water area yields up to 12 metric tons of herbivorous fish, of carp and a sturgeon hybrid. Trout grown in the subsaline water fish ponds of the Pyarnu bay in the Baltic Sea develop one and a half to two times faster than in fresh water

and have a higher percentage of fat.

A whole network of fish-breeding farms soon to be built in the USSR will make it possible to reduce commercial fishing of some valuable kinds of sea fish, whose population has been declining at a disastrously rapid rate, without affecting the amount of fish products in the Soviet people's diet.

Another important part of the problem of controlled fish-breeding is the artificial breeding of marine fish which, Soviet scientists believe, could increase and supplement the natural population. This is a very complex problem as it includes the study of all the stages of the fish life cycle. The fry obtained must be in no way inferior to the fry produced by natural spawning.

The artificial reproduction of fish was first tackled in the USSR on quite a wide scale as far back as the 1930's

return sometimes amounts to 5 to 7 percent. Along with Japan and the United States, the USSR can be considered with the largest producers of salmon fry in the world.

At present Soviet research institutes are also studying the life cycle and migratory patterns of such sea water fish as plaice, cod and ocean herring. The researchers are working out techniques to stimulate growth, methods of incubation and ways of providing the larvae with food.

At the Pacific Scientific-Research Institute of Fishing Economy and the Institute of the Biology of the Sea of the Institute of the Biology of the Sea of the USSR Academy of Sciences in Vladivostok, a series of experiments are being carried out to breed many sea animals and plants, such as large sea staff and other algae, scallops, oysters, trepang, plaice, red rock trout, mullet and others.



and 1940's in connection with the adoption of measures for the control of the fishing economy in the Caspian and the Azov seas. At present 70 million sturgeon fry are let out annually into the Caspian and Azov seas. This greatly exceeds the potentials of natural spawning.

Much has been also achieved in the artificial breeding of the Atlantic and Pacific salmon. The Soviet Union has several large fish nurseries for the breeding of the Baltic salmon and dozens of fish farms for the breeding of the Pacific salmon. The production of these nurseries is numbered in millions of fry, while the commercial

## Japan Explores Papua New Guinea Shrimp

The Papua New Guinean government recently permitted three Japanese fishery firms to conduct experimental shrimp fishing in the Gulf of Papua for six months, until the end of December, according to Japanese press reports. Two of the firms, Kyokuyo and Hokoku Suisan, which are conducting fishing in Papua New Guinea in partnership with Australian interests (Gollin Kyokuyo Fishing Company and New Guinea Marine

<sup>1</sup> The author, Sergei Doryshev is in charge of a laboratory at the USSR Scientific-Research Institute of Fishing Economy and Oceanography. His article is provided courtesy of the Novosti Press Agency, Moscow.

Products Company) plan to operate five and four vessels, respectively, and a Taiyo-affiliated trading firm will employ two vessels, for a total of 11.

Papua New Guinea, an Australian territory which is scheduled to become a self-governing state in December 1973, for several years has been focusing attention on the development of the fishing industry for establishment of an independent economy and has been actively seeking foreign fishery investments, particularly from Japan.

The shrimp exploratory survey is the administration's second fishery development project, the first being the skipjack fishing and canning venture by the Papua New Guinea Can-

ning Company, which is likely to begin commercial-scale operations next year with the participation of Japanese, American, and Australian interests.

#### Publications

### Recent NMFS Scientific Publication

NOAA Technical Report NMFS CIRC-376. Colton, John B., Jr., and Ruth R. Stoddard. "Bottom-water temperatures on the continental shelf, Nova Scotia to New Jersey." June 1973. 55 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 60 cents. (No abstract.)

fish supply difficulties and price competition with foreign buyers.

### BLOCKS, STICKS, AND PORTIONS

The block shortage continued to worsen in June compared with a year ago, although there was some very slight improvement in holdings from the previous month (Table 7).

Imported block prices had been soaring all year (Table 8), and by June the margin between the raw material (blocks) and the finished goods (sticks and portions) had narrowed to a point where the replacement cost of the raw material was higher than the revenue received from sales of the finished goods (Figure 1). The announcement of the price freeze in early June placed sticks and portions producers in a cost-price squeeze since imported block prices were free to increase while stick and portion prices remained fixed under the freeze regulations.

There is little hope for immediate improvement in block supplies; however, relaxation of price controls in Phase IV will permit processors of sticks and portions to pass on some of their higher raw material costs.

#### Monthly Fishery Market Review

### Tight Supplies, Heavy Demands Are the Rule

#### FISH FILLETS

Supplies of major groundfish fillets (cod, flounder, haddock, and ocean perch) available for consumption in June were well above a year ago (Table 1). Gains in consumption of fillets, however, fell far short of matching the increases experienced on the supply side. The result has been a large inventory buildup of major fillet items during the first half of the year.

The fact that consumption has not kept pace with growing supplies does not appear to be closely related to higher prices (Table 2). Rather, stockpiling of fillets appears to have become a major inventory strategy this year. Fillet inventories are now more than double year ago levels (Tables 3-6). In the coming months, the meat and poultry shortage is expected to become acute. Demand for fishery products, in turn, likely will increase and the heavier inventories will be available to satisfy any increase in demand.

It is also expected that import prices

for fillets, cod in particular, will increase for the following reasons: a) poor catches in most major supplying nations; b) strong world demand; and c) continued currency realignments.

Given this outlook, many U. S. processors, by purchasing heavily now, may be trying to hedge against future

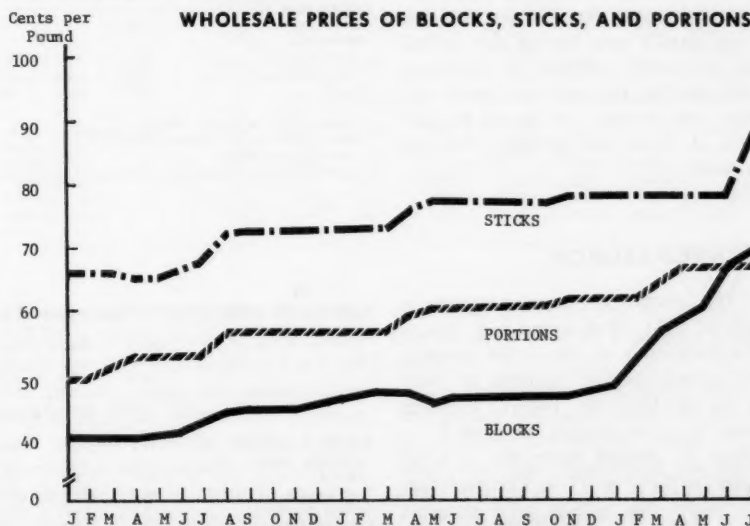


Figure 1.—Wholesale prices of blocks, sticks, and portions.

This action will result in a sudden bulge in prices for sticks and portions.

World cod supplies are very short this year, as a result of poor catches in major cod fishing nations, and U.S. processors may look more seriously at alternative species to augment dwindling block supplies. Many previously lesser utilized species are gaining acceptance by both processors and consumers, both for reasons of lower cost and higher availability. Thus, the shift towards species such as Alaska pollock, Greenland turbot, and minced blocks should become more pronounced as the year progresses. U.S. processors have drawn heavily on inventories to satisfy demand this year and this has resulted in a larger drawdown of holdings from January through June than ever before experienced by the industry. Thus, despite the fact that U.S. production of fish sticks and portions through June of this year was above a year ago (Tables 9 and 10), reserve supplies of blocks are precariously low. As of July 1, U.S. holdings of fish blocks were barely more than half of last year's level. Inventories of blocks traditionally begin to increase in May, in preparation for seasonally heavy fourth quarter production. Although block inventories did inch up slightly during June, the increase was far less than usually seen during this period. If processors continue to encounter difficulty in acquiring new block supplies, the outlook for heavy production of sticks and portions this fall is bleak.

## CANNED SALMON

The picture for canned salmon is one of tight supplies and high prices. An indication of the small quantity of canned salmon available in 1973 is the fact that only 148,617 standard cases were in storage on June 1 — about 81 percent below the 778,573 cases on hand in 1972. The depletion of inventories reflects poor progress in the 1973 pack. Whereas 1-pound

**Table 1.—Inventory, supplies and consumption of groundfish fillets, including cod, flounder, haddock, and ocean perch, June 1973.**

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan 1973	June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	34.3	31.1	34.5	14.9	+ 132	52.4	45.1	+ 16
Landings, Total	5.7	6.7	6.7	6.5	+ 3	33.3	34.7	- 4
Imports	25.5	25.4	33.9	24.9	+ 36	148.2	117.2	+ 26
Total Supply	65.5	63.2	75.1	46.3	+ 62	233.9	197.0	+ 19
Ending Inventory	31.1	34.5	42.6	17.8	+ 139	42.6	17.8	+ 139
Consumption	34.4	28.7	32.5	28.5	+ 14	191.3	179.2	+ 7

**Table 2.—Ground fish prices June 1973 (all wholesale prices fob Boston, Gloucester, and New Bedford).**

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan 1973	June 1972	Percent Change
	---- Cents Per Pound ----				Percent	Cents Per Pound		Percent
<b>COD</b>								
Ex-vessel <sup>1</sup>	20.0	13.1	14.3	16.4	- 13	20.1	20.4	- 1
Wholesale								
1 lb Canadian	61.5	62.0	66.1	56.0	+ 18	60.2	54.7	+ 10
5 lb Canadian	58.0	59.6	63.5	55.5	+ 14	55.9	53.8	+ 4
Retail <sup>2</sup>	184.0	174.5	170.6	124.0	+ 38	179.8	131.2	+ 37
<b>FLOUNDER</b>								
Ex-vessel <sup>3</sup>								
Yellowtail	32.37	18.30	15.78	20.92	- 25	29.65	20.46	+ 45
Lemonsole	44.00	24.84	28.57	28.98	- 1	41.80	38.47	+ 9
Greysole	29.40	19.06	19.17	21.13	- 9	29.10	26.01	+ 12
Blackback	30.05	17.91	18.48	21.23	- 13	26.92	32.47	- 17
Wholesale								
5 lb domestic	111.3	95.7	85.6	93.8	- 9	95.6	87.7	+ 10
5 lb Canadian	80.5	80.2	80.0	64.0	+ 25	79.3	57.6	+ 38
Retail <sup>2</sup>	236.6	224.0	216.6	166.5	+ 30	214.3	161.5	+ 33
<b>HADDOCK</b>								
Ex-vessel <sup>1</sup>								
Large	49.7	44.5	40.8	39.0	+ 5	45.1	41.7	+ 8
Scrod	32.5	32.2	21.3	27.2	- 22	27.9	33.5	- 17
Wholesale								
5 lb Canadian	79.3	79.5	79.9	68.8	+ 16	78.6	60.8	+ 29
Retail <sup>4</sup>	124.2	128.7	132.2	104.9	+ 26	123.5	103.4	+ 19
<b>OCEAN PERCH</b>								
Ex-vessel <sup>1</sup>	7.6	7.5	7.5	5.3	+ 42	7.3	5.4	+ 35
Wholesale								
5 lb domestic	61.5	63.0	59.3	44.0	+ 35	59.5	38.1	+ 56
5 lb Canadian	54.3	55.4	55.5	41.5	+ 34	53.4	38.0	+ 41
Retail <sup>4</sup>	94.4	96.9	99.6	73.8	+ 35	93.4	73.3	+ 27

<sup>1</sup> Quotes taken at Boston, Mass.

<sup>2</sup> New York Consumer Market Reports.

<sup>3</sup> New Bedford, Mass.

<sup>4</sup> Bureau of Labor Statistics — average of 36 U.S. cities.

**Table 3.—Cod (fillet weight in millions of pounds) supplies, June, 1973.**

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	13.1	13.3	14.7	7.5	+ 96	16.2	6.2	+ 161
Landings, Total	1.4	1.8	1.5	1.3	+ 15	7.5	7.4	+ 1
Imports	10.7	6.4	9.4	11.1	- 15	48.7	50.0	- 3
Total Supply	25.2	21.5	25.6	19.9	+ 29	72.4	63.6	+ 14
Ending Inventory	13.3	14.7	15.7	9.2	+ 71	15.7	9.2	+ 71
Consumption	11.9	6.8	9.9	10.7	- 7	56.7	54.4	+ 4

cans normally account for a large portion of production during good pack years, supplies this year consist primarily of one-fourth and one-half pound cans. The switch to packing smaller sized cans is an apparent effort to increase the number of units available for sale.

With the 1973 season's salmon pack nearly complete, preliminary reports indicate that the Alaskan pack reached only 531,000 standard cases through the sixth week of the season — down nearly 41 percent from the low pack in 1972. This was far below preseason estimates of a six percent decline from 1972.

Prices at all levels have been extremely high recently as a result of the poor packs in 1972 and 1973. Ex-vessel prices had generally stabilized at 97 cents per pound throughout much of the landings season — 29 percent above the previous year. However, they rose to \$1.02 as the season came to an end.

Wholesale prices were likewise high. Prices for reds were \$58 per case (48 1-lb talls), during June (up 23 percent), while pink prices were stable at \$47; a 25 percent increase above the previous June.

## SHRIMP

Supplies of shrimp available for consumption remained well below the previous year in June (Table 11) as imports and landings were again off, causing June 1 inventories to be drawn below 1972 for the first time this year. Although below the previous year, landings improved in June, giving some relief to the tight supply situation that had developed in the second quarter. The heavy flow of fresh water into the Gulf during the early spring apparently has not had a significant adverse effect on this year's shrimp crop as had been at first suggested. Imports also continued to decline with total shipments off 35 percent during June and 16 percent during the first half of the year.

The effects of competition with the

Table 4.—Ocean perch (fillet weight in millions of pounds) supplies, June, 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	5.9	4.2	5.5	2.8	+ 96	17.8	20.7	- 14
Landings, Total	1.8	1.7	1.8	2.1	- 14	9.7	10.3	- 6
Imports	4.5	8.1	9.5	5.4	+ 76	31.1	23.8	+ 31
Total Supply	12.2	14.0	16.8	10.3	+ 63	58.6	54.8	+ 7
Ending Inventory	4.2	5.5	10.2	3.5	+191	10.2	3.5	+191
Consumption	8.0	8.5	6.6	6.8	- 3	48.4	51.3	- 6

Table 5.—Haddock (fillet weight in millions of pounds) supplies, June, 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	9.5	8.4	8.3	1.8	+361	9.8	8.9	+ 10
Landings, Total	0.3	0.3	0.5	0.5	—	1.8	2.3	- 22
Imports	3.0	3.6	4.0	2.9	+ 38	21.4	13.9	+ 54
Total Supply	12.8	12.3	12.8	5.2	+146	33.0	25.1	+ 31
Ending Inventory	8.4	8.3	8.3	2.1	+295	8.3	2.1	+295
Consumption	4.4	4.0	4.5	3.1	+ 45	24.7	23.0	+ 7

Table 6.—Flounder (fillet weight in millions of pounds) supplies, June, 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	5.8	5.2	6.0	2.8	+114	8.6	9.3	- 8
Landings, Total	2.2	2.9	2.9	2.6	+ 12	14.3	14.7	- 3
Imports	7.3	7.3	11.0	5.5	+100	47.0	29.5	+ 59
Total Supply	15.3	15.4	19.9	10.9	+ 83	69.9	53.5	+ 31
Ending Inventory	5.2	6.0	8.4	3.0	+180	8.4	3.0	+180
Consumption	10.1	9.4	11.5	7.9	+ 46	61.5	50.5	+ 22

Table 7.—Supplies of blocks and slabs, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan 1973	June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	40.4	32.4	32.3	61.4	-48	75.8	62.7	+ 21
Production	0.3	0.4	0.4	0.3	+33	0.4	0.2	+100
Imports	18.7	29.8	31.3	32.8	- 5	143.8	181.7	- 21
Total Supply	59.4	62.6	64.0	94.5	-32	220.9	244.6	- 10
Ending Inventory	32.4	32.3	33.1	62.9	-47	33.1	62.9	- 47
Consumption	27.0	30.3	30.9	31.6	- 2	186.9	181.7	+ 3

Japanese for world supplies of shrimp are again being observed, particularly from India, where shipments are off 66 percent from the January-June period in 1972. With both landings and imports below the previous year, inventories were drawn lower further during the month, although the rate of decline slowed somewhat. By July 1, holdings had declined about 45 per-

cent from the beginning of the year, compared to only an 8 percent drop in 1972.

The increasingly tight supply situation caused wholesale prices to move up early in the month (Table 12). After the price freeze was put into effect on June 12, prices moved down, apparently adjusting to the freeze regulations. With the start of the new

Table 8.—Prices of blocks and slabs, 1972 and 1973.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		----- Cents Per Pound -----											
Cod	1972	46.5	47.0	47.0	47.0	45.6	46.5	47.0	47.0	47.0	47.0	47.0	48.0
	1973	48.6	52.4	56.6	58.5	61.1	66.7						
Flounder	1972	43.5	44.4	45.3	49.2	51.7	53.3	55.6	57.0	58.0	58.0	58.7	59.5
	1973	59.5	59.6	60.0	60.0	60.0	62.0						
Haddock	1972	47.1	47.5	47.5	47.9	50.3	52.8	54.4	57.0	58.1	59.5	59.5	59.5
	1973	60.1	60.5	61.4	63.3	64.9	69.0						
Ocean perch	1972	38.5	38.5	38.7	39.5	39.5	39.8	41.6	45.0	48.0	48.3	49.4	49.5
	1973	51.2	53.1	53.9	54.0	54.8	53.9						
Pollock	1972	32.3	32.0	32.0	32.1	31.2	31.5	31.5	31.0	29.6	29.5	28.3	28.0
	1973	29.0	30.1	33.0	34.0	35.2	39.8						
Whiting	1972	33.0	33.5	33.0	33.0	33.2	31.5	31.5	31.5	31.5	32.0	34.1	34.5
	1973	34.6	35.8	37.5	37.5	37.5	39.4						
Wolffish	1972	49.3	50.0	50.0	50.0	50.3	50.5	51.0	51.5	51.3	51.0	51.0	51.0
	1973	51.0	50.0	54.5	52.0	52.0	52.0						

Table 9.—Supplies of sticks and portions, June 1973.

	April	May	June	June	Percent	Jan	June	Percent
	1973	1973	1973	1972	Change	1973	1972	Change
	----- Million Pounds -----				Percent	Million Pounds	Percent	
Beginning Inventory	25.9	24.3	27.5	20.3	+35	34.4	23.2	+48
Production:								
Sticks	11.6	10.9	8.6	7.9	+9	37.7	32.9	+15
Portions	24.3	26.1	22.5	21.4	+5	72.5	65.0	+12
Total	35.9	37.0	31.1	29.3	+6	110.2	97.9	+13
Imports	0.2	0.2	0.2	0.2	—	1.0	0.8	+25
Total Supply	62.0	61.5	58.8	49.8		145.6	121.9	
Ending Inventory	24.3	27.5	31.6	24.8	+27	31.6	24.8	+27
Consumption	37.7	34.0	27.2	25.0		114.0	97.1	

Table 10.—Weekly average prices of sticks and portions, June 1973.

	April	May	June	June	Percent	Jan	June	Percent
	1973	1973	1973	1972	Change	1973	1972	Change
	----- Cents Per Pound -----							
Wholesale								
Cod portions	67.0	67.0	67.0	60.5	+11	64.9	58.6	+11
Haddock	69.5	69.5	69.5	65.0	+7	69.2	63.4	+9
Cod sticks	78.0	78.0	78.0	77.0	+1	78.0	74.8	+4
Haddock sticks	80.0	80.0	80.0	79.2	+1	80.0	76.9	+4

season, ex-vessel prices declined seasonably but were nevertheless well above the previous year. Retail price movements were mixed with large count shrimp declining and medium count prices rising.

Consumption of shrimp was unseasonably high in June in spite of the relatively high prices. June consumption of 36.1 million pounds was only 4 percent above June 1972 but was 10 million pounds above the previous month. It appears that the publicity concerning high meat prices has not aided sales significantly since the quantity consumed during the first

half of 1973 was only 2 percent above that in 1972.

## SCALLOPS

On the basis of high inventories, supplies of scallops in June were 42 percent above the previous year (Table 13). Although landings and imports were below the previous year in June, both were higher during the January-June period, rising 5 and 27 percent respectively.

Consumption during the month was off 21 percent from 1972, probably the result of the high level of retail

prices which were 15 percent above the previous year. Again, June did not reflect the six-month picture as January-June consumption was 20 percent above 1972.

Unlike retail prices, those at the ex-vessel and wholesale levels were well below the previous year (Table 14). Prices at all levels, however, have been declining in recent months; probably in reaction to the high and rising level of holdings.

## AMERICAN LOBSTERS

Supplies of American lobsters were down sharply in June (Table 15) owing to a 36 percent decline in imports. Maine landings continued to show improvement over last year as a 35 percent gain in June contributed to a 57 percent rise during the first half of the year. A 36 percent drop in the quantity of lobsters received from Canada in June resulted in the 6 month total being off 9 percent. Two factors appear to have caused the recent decline in imports. First, the relatively low level of prices (Table 16), when compared to April, probably caused Canadian exporters to withhold supplies from the market. Second, the price freeze probably caused domestic importers to withdraw from the market somewhat since increased costs could not be passed on to the consumer. Because the Canadian lobster fishermen, like those in the United States, are undoubtedly having a good season, this situation is expected to be only temporary.

## SPINY LOBSTER TAILS

Supplies of spiny lobsters were well below the previous year in June (Table 17) as both holdings and imports were down. Inventories, however, recorded a slightly larger increase than during the same month in 1972 as consumption was off 22 percent. The increase in holdings indicates that high prices may be affecting demand somewhat. Prices for both warm-water and cold-

Table 11.—Shrimp supplies, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	67.6	58.2	55.0	55.9	- 2	92.7	69.9	+ 33
Landings								
Total	7.8	14.4	27.8	28.6	- 3	82.5	89.1	- 7
Gulf	4.0	8.0	17.5	17.6	- 1	43.1	53.9	- 20
Northeast	.9	.7	1.0	1.4	-29	9.7	11.7	- 17
Pacific	2.9	5.3	7.6	8.1	- 6	27.5	20.2	+ 36
South Atlantic		.4	1.7	1.5	+13	2.2	3.3	- 33
Imports	15.2	14.5	15.4	23.6	-35	100.3	119.3	- 16
Total Supply	90.6	87.1	98.2	108.1	- 9	275.5	278.3	- 1
Ending Inventory	58.2	55.0	50.6	64.1	-21	50.6	64.1	- 21
Exports								
Total	4.4	4.2	3.5	2.7	+30	28.1	19.1	+ 47
Domestic Fresh & Frozen								
Transshipments	2.8	3.1	2.7	2.2	+23	20.9	16.1	+ 30
Gulf Canned Pack	1.6	1.1	.8	.5	+60	7.2	3.0	+140
Fresh & Frozen Consumption	—	1.8	8.0	6.6	+21	10.7	12.0	- 11
	28.0	26.1	36.1	34.7	+ 4	186.1	183.1	+ 2

Table 13.—Scallop supplies, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Thousand Pounds ----				Percent	Thousand Pounds		Percent
Beginning Inventory	2,751	2,954	3,083	1,026	+200	3,736	1,585	+136
Landings, Total	683	694	560	720	- 21	3,405	3,253	+ 5
Imports	1,370	2,175	1,638	1,961	- 16	9,598	7,531	+ 27
Total Supply	4,804	5,823	5,281	3,707	+ 42	16,739	12,369	+ 35
Ending Inventory	2,954	3,083	3,159	1,012	+212	3,159	1,012	+212
Consumption	1,850	2,740	2,122	2,695	- 21	13,580	11,357	+ 20

Table 15.—American lobster supplies, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Thousand Pounds ----				Percent	Thousand Pounds		Percent
Maine Landings	317	1,280	914	675	+35	3,242	2,062	+57
Imports	1,493	3,517	5,309	8,352	-36	14,982	16,377	- 9
Consumption	1,810	4,797	6,223	9,027	-31	18,224	18,439	- 1

Table 17.—Spiny lobster tail supplies, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change	Jan- June 1973	Jan- June 1972	Percent Change
	---- Million Pounds ----				Percent	Million Pounds		Percent
Beginning Inventory	7.9	7.4	6.9	7.4	- 7	8.9	4.7	+89
Imports	2.4	2.6	2.9	3.4	-15	17.7	21.5	-18
Total Supply	10.3	10.0	9.8	10.8	- 9	26.6	26.2	+ 2
Ending Inventory	7.4	6.9	7.3	7.6	- 4	7.3	7.6	- 4
Consumption	2.9	3.1	2.5	3.2	-22	19.3	19.6	- 2

water tails rose during the month (Table 18) although the price freeze retarded the increases during the second half of the month. The growth in inventories further indicates that prices may peak in the near future.

Table 12.—Shrimp prices, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change
	---- Dollars Per Pound ----				
Ex-vessel					
15-20 count	2.06	2.14	2.12	2.03	+ 4
31-35	1.81	1.84	1.70	1.39	+22
51-65	1.35	1.34	1.30	.74	+76
Wholesale					
15-20 count	2.19	2.28	2.34	2.29	+ 2
31-35	1.95	1.99	2.06	1.64	+26
51-65	1.51	1.54	1.58	.97	+63
Retail					
15-25 count	3.65	3.01	2.94	2.99	- 2
31-42	2.26	2.28	2.38	2.09	+14

Table 14.—Scallop prices, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change
	---- Dollars Per Pound ----				
Ex-vessel	1.76	1.44	1.44	2.01	-28
Wholesale	2.23	1.82	1.64	2.18	-25
Retail	3.23	3.08	3.03	2.64	+15

Table 16.—American lobster prices, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change
	---- Dollars Per Pound ----				
Ex-vessel	1.43	1.29	1.37	1.68	-18
Wholesale					
2 lb.	2.83	1.92	1.97	2.20	-10
1½	2.55	1.87	1.96	2.12	- 8
1¼	2.06	1.80	1.93	2.18	-11
1½	2.00	1.77	1.90	2.18	-13
chix	1.99	1.76	1.89	2.20	-14

Table 18.—Spiny lobster tail prices, June 1973.

	April 1973	May 1973	June 1973	June 1972	Percent Change
	---- Dollars Per Pound ----				
Wholesale Price					
6-8 oz tail					
Cold-water	4.64	4.71	4.82	4.45	+ 8
Warm-water	3.33	3.65	3.82	3.77	+ 1

## Bookstores and Fisherpersons

● In the August number of MFR, I listed the NMFS Scientific Publications and said that most of them can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. This is true, but I should have mentioned that they are also available from the several Government Printing Office Bookstores across the country. Often service will be faster if one orders publications from the nearest Bookstore. The bookstores will accept subscriptions to our periodicals.

The Seattle Bookstore is the newest in the group. If it will serve as an

example, you may expect prompt, knowledgeable, and courteous service.

● Peter Pownall, editor of that fine publication *Australian Fisheries*, dropped by Seattle recently on a vacation trip that was to take him around the world. He had a good many interesting things to say, both about *Australian Fisheries* and Australian fisheries.

Per capita fish consumption in Australia is about the same as in the United States — around 12 pounds a year. The country is exporting most of its fish catch. The carefully regulated rock lobster fishery off Western Australia has been thriving, with prices for rock lobster tails reaching \$5.40 a pound recently.

The prawn fishery, mostly in the Gulf of Carpentaria, in the tropical north of Australia, has been growing prodigiously — from a total catch of

less than a million pounds five years ago to a predicted 40 million pounds in 1973.

There are about 200 vessels in the prawn fleet that fishes the Gulf of Carpentaria. Even at the height of the season, they must be pretty well scattered out: The Gulf of Carpentaria is just about the same size as the Gulf of Mexico.

Australia has become the second largest exporter of abalone (Mexico is the first), which are caught in the cool waters around Tasmania. Most of the abalone are exported to Asia.

One of the oldest and most colorful fisheries in the South Pacific, if not in the world, is still in business, by the way. That is the fishery for pearls in the Torres Strait, at the northeastern tip of the continent. Plastics, of course, have long eliminated mother-of-pearl, formerly the mainstay of the fishery, and used for buttons, as a valuable fishery product. However, oysters are still cultured for the pearls they produce. The oysters are immense: "as big as a dinner plate." One oyster can be expected to produce three marketable pearls in its lifetime. These are large, premium pearls, selling for about \$250 each retail. They are exported to Japan and used chiefly in necklaces.

Mr. Pownall had one item of information that may raise the hackles of any male chauvinists among our readers. It is becoming a fairly common thing for women to work as fishermen, particularly in the prawn fishery. There are some vessels with all-female crews. The women fishermen are working out well. They come from all over the world. Some have had training as nurses and teachers. Most are young, in their late teens or early twenties. They make good fisherpersons (a word Mr. Pownall did not use, by the way). Many of them "are more intelligent than the average man." Certainly they are pretty well paid: the average fisherman (woman) (person) makes ten to fifteen thousand dollars a year, and some make a great deal more.

T.A.M.

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